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OF

PHYSIOLOGICAL ACOUSTICS AND AURAL SURGERY

EDITED BY

CLARENCE J. BLAKE, M.D.

IN CONJUNCTION WITH

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INTRODUCTORY.

The past ten years have seen a remarkable increase in the interest in the study of the laws which govern the production and propagation of sonorous vibrations, and correspondingly in the study of the structure, functions and diseases of the complicated apparatus which enables us to appreciate that mode of motion to which we give the name of sound.

The work which is being done in the field of otology, and which is evidenced in the papers containing records of original investigations appearing in almost every scientific publication and in the reports of the proceedings of scientific societies throughout the world, naturally suggests to the physicist the better appreciation of the structure and functions of the organ of special sense to the study of which his investigations in acoustics lead, and to the aural surgeon the necessity of overstepping what has usually been considered the boundary of his professional province by turning his attention to investigations in physics as the groundwork of his physiological and pathological studies, in order that he may be the better qualified to make that practical application of the knowledge to be so acquired in the conservative treatment of the various diseases of the human ear.

To investigations in acoustics a new impetus has been given by two recent inventions—one the natural outcome of the other—the telephone and the phonograph, and it is not too much to say that the gain to science from the solution of the problems which these instruments suggest will surpass the immediate practical advantages to be derived from them.

In a lecture delivered in Berlin, in 1869, Prof. Dové remarked that for sixty years past the attention of physicists had been

196528

directed to investigation of the laws of optics, that field having been thoroughly and almost exhaustively worked, and that during the sixty years to come still greater discoveries would be made in the domain of acoustics.

The progress which has since then been made affords evidence of the fulfilment of this prophecy, and, taken in connection with the growing appreciation of the importance of the special sense of hearing, not only gives an enhanced value to the study of the structure and of the diseases of the human ear, but also renders a knowledge of the more important investigations in physiological acoustics incumbent upon the aural surgeon.

A recognition of these facts has led to the founding of this journal, which is therefore intended to afford a medium for the publication of original communications on subjects coming within the scope of the two departments to which it is devoted, and also to furnish a series of reviews of the more important papers on subjects pertaining to acoustics and aural surgery published in other journals and in the reports of scientific societies.

THE GRAPHIC AND PHOTOGRAPHIC ILLUSTRATION OF SOUND-WAVES.

BY CLARENCE J. BLAKE, M.D., BOSTON.

I.

A DECIDED advance in the means afforded for the study of sonorous vibrations was made by Wilhelm Weber,[1] when, in 1830, he first devised a practical method for recording the sound-producing movements of vibrating bodies; the means by which this was accomplished, and which has formed the basis of all subsequent methods of graphic illustration of sound-waves was very simple, consisting merely in attaching a stylus, preferably of metal, and having a sharp point, at a right angle to the plane of vibration of the sounding body, a tuning-fork, for instance, and then moving the tuning-fork set in vibration over a glass plate, smoked, or otherwise prepared, for reception of a tracing, in a direction at a right angle to the line of excursion of the vibrating prongs of the fork, the result being a sinuous line, the curves of which would vary with the pitch, the degree of excursion of the prongs of the fork, and the speed with which the fork was moved over the glass plate.

By noting the length of time required to pass the tuning-fork over a given space, and then counting the number of curves, the pitch of the tuning-fork, or other sound-source from which the vibrogram was obtained, was determined.

Weber's procedure was also applied to obtaining compound vibrograms by attaching the recording surface to the prong of one tuning-fork, and making a tracing by means of a stylus attached to the prong of a second tuning-fork.

The first perfected instrument for the systematic record of vibrations was the vibroscope of Duhamel,[1] consisting of a glass cylinder revolved by hand-power, and pivoted in a framework so arranged that the cylinder could be placed at any desired angle, and having a spiral thread upon the shaft, which permitted the recording of a continuous line upon the smoked glass surface.

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[1] Wilhelm Weber, Akustik, Stuttgart, 1830.

König improved this apparatus by running the cylinder horizontally upon firm supports, thereby increasing the stability of the instrument, a matter of great importance for the attainment of a reliable record, and by adding a pointer moved by an electro-magnet in connection with a second's pendulum, which marked the rate of revolution of the cylinder upon smoked paper; this paper, bearing the record of the vibrations and the time record, could be removed, varnished, and preserved.

The instruments here briefly mentioned served to record directly the vibrations of various forms of sound source, but it was not until the invention of the membrane phonautograph of Scott that a means was provided for recording the movements of a membrane set in vibration by the impact of sound-waves communicated through the medium of the air.

This instrument, which included some of the elements of the first telephone of Reis, and the phonograph of Edison, consisted of a large chamber, open at both ends, the smaller opening being covered by a membrane, the tension and position of which could be regulated by the pressure of an enclosing metal ring moved by set screws. The stylus, fastened to a set screw, sliding in a slot cut in a metal arm, projecting over the surface of the membrane, and thus permitting variation of its point of contact, consisted of the rib of a delicate feather, bearing at the end a bristle, which made its record upon a cylinder similar to that employed in the later forms of vibrograph.[2]

König improved the mechanism of Scott's apparatus, and constructed the phonautograph now in common use. That Scott derived the idea of his membrane phonautograph from a study of the structure of the human membrana tympani and ossicula is shown by the fact that, in first constructing his instrument, he attempted to imitate the ossicula in making his stylus.

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[1] **M. J. Jamin, Paris, 1859.**

[2] **Phonautographs of Scott and König, various publications, 1859. Pisko, Apparate der Akustik, Wien, 1865.**

An elaboration of the same idea is found in the improvement recently made by Mr. Morey, of the Massachusetts Institute of Technology, in attaching the end of a long lever to the periphery with a point of support in the centre of the membrane.

The perfected phonautograph of König was immediately made available by many investigators, among them Bourget and Bernard; Marx, who employed the instrument in his experiments on the vibrations of membranes; Donders,[1] and Prof. Adam Politzer, who, in addition to conducting experiments with König, employed the graphic method in physiological investigations and obtained phonautograms from the human membrana tympani, and from the membrana tympani of birds.[2]

In reviewing the work of these writers it is interesting to note the unanimity with which the opinion is expressed that the original expectation of Scott, the transcription of distinctive autograms of words must ever remain unfulfilled, and there is nowhere to be found a hint of the possibility of making a permanent record of the vibrations which could be used to recommunicate the recorded vibration to the membrane, and so reproduce the sound itself.

The accomplishment of what has been justly called the acoustic marvel of this century remained for Mr. Edison, who was led to the construction of the talking phonograph by a consideration of the marked vibration of a ferrotype telephone disk in response to the human voice.

The first idea of the phonograph, and the train of thought which led to it, came through an instrument called the embossing translator, invented by Mr. Edison for the Western Union Telegraph Company, in which the Morse characters are indented on a strip of paper, and then reproduced by means of a lever. In

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[1] Zur Klangfarbe der Vocalen. Poggendorf's Annalen, 1864. Pisko, Apparate der Akustik, 1865.

[2] Untersuchungen über Schallfortpflanzung und Schallleitung. Archiv für Ohrenheilkunde, 1864, and Lehrbuch der Ohrenheilkunde. Wien, 1874.

[3] Professor A. M. Mayer: "Edison's Talking Machine," Popular Science Monthly, April, 1878.

July, 1877, the idea occurred to him of substituting for the magnet and lever a diaphragm and point, and thus reproducing speech; but at the time the due importance was not attached to the conception, from the supposition that the rapidity of the vibrations of the disk would not allow the needle-point to drop into the indentations with sufficient accuracy. Soon after this an experiment was made in which a strip of paper half an inch wide was drawn through a groove under a telephone disk, with a needle attached, the disk being set in vibration by the voice. On drawing the paper a second time under the disk, the words previously spoken were clearly distinguishable. This experiment demonstrated the practicability of the mechanical reproduction of speech, and the first phonograph was constructed in October of the same year.

Tin-foil containing a large percentage of lead was finally chosen as the matrix for the reception of the indented record, and was found to answer its purpose admirably, not only receiving readily the more delicate impressions of tones of slight intensity, but retaining these impressions sufficiently to permit of repeated audible reproductions.

Aside from the practical advantages to be derived from the future development of the Edison phonograph, this instrument not only affords an opportunity for the analytical study of the sound record, but also affords a controlling test of the accuracy of the record by providing for its audible reproduction.

As, however, the record made is vertical to the surface of the matrix, it becomes necessary, in order to study the outline, to obtain a secondary tracing, or to make a longitudinal section of the line of indentations in the foil. The second of these objects is accomplished by backing the tin-foil removed from the cylinder after recording with a soft alloy and then making a longitudinal section with a sharp knife or circular saw, or by taking a cast of the furrow and making a similar section.

The first method, mentioned by Prof. A. M. Mayer[1] and elaborated and employed by Prof. Fleeming Jenkyn and Mr. Ewing, in a series of elaborate investigations now in progress, consists in mechanically transcribing the indentations made in the tin-foil in such a manner as to give curves representing a magnified section of the impressions; this is done by means of a system of compound levers recording by an arrangement resembling the siphon recorder of Sir W. Thompson.

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[1] **"Edison's Talking Machine."**

In these magnified curves, which form the subject of the papers of Prof. Jenkyn and Mr. Ewing, the vertical ordinates of the curves drawn in ink are about four hundred times larger than the corresponding indentations in the tin-foil, while the longitudinal ordinates are magnified about seven times.[1]

The slowness of the motion by which the transcript was made ensured the avoidance of all error due to inertia of the working parts, and the total absence of friction between the marking siphon and the paper allowed the transcript to be made without employing such a pressure on the tin-foil as would sensibly alter the indented curves. This fact was in each case tested by making the phonograph speak the vowel after it had been copied, all transcripts being rejected if the tin-foil did not continue to give the sound clearly after being used to produce these curves.[2]

While the former phonautographs therefore afford only a means of making tracings of the vibrations of the membranes employed, and furnish no controlling test of the accuracy of their records, the Edison phonograph supplies a test by means of the sense of hearing.

The absolute value of this test may, however, in the present stage of perfection of the instrument be subject to question, the varying opinions of different observers upon the result of the audible reproduction of vowel sounds by the phonograph serving to illustrate this.

In all the appliances thus far provided for the graphic illustration of sound-waves there is presented a possible element of error which would permit the question as to the accuracy of the tracings; this lies in the friction of the recording stylus upon the smoked, or otherwise prepared surface upon which the tracing is made, and in the inertia of the stylus itself.

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[1] "The Phonograph and Vowel Sounds," Nature, July, 1878.

[2] Ibid.

A further element of error in the instruments generally in use, when tracings are made for purposes of comparison, results from the difficulty of ensuring perfect steadiness of motion of the receiving plate, or cylinder,[1] and the want of a fixed standard of proportional speed of movement of the recording surface.

As an instance of the possible effect of friction may be taken records of vowel sounds at a determined pitch made with the membrana tympani phonautograph,[2] in which the tracing was made by a stylus formed of a single fibre of wheat straw attached to the malleus, and tracing upon a smoked glass plate, the movement of which was accurately tested. On careful examination of these tracings, Prof. E. W. Blake, Jr., found the number of recorded vibrations to fall considerably below the ordinary pitch of the voice, being, in some cases, as low as eighty vibrations in the second.

By employing a sensitive plate instead of a prepared surface for graphic record, and a mirror and beam of light in place of a recording stylus, the element of error resulting from friction and from inertia is largely disposed of.

In a recent paper Prof. Blake describes a method of obtaining photographs of minute vibrations on a magnified scale.

In 1876 Dr. S. T. Stein[3] proposed a means of photographing the vibrations of tuning-forks by attaching perforated plates of blackened mica, through which a beam of light was allowed to fall upon a sensitive plate moving with uniform velocity. By this method Dr. Stein expected to be able to record vocal sounds, but apparently did not carry out the project, and Prof. Blake, in repeating the experiments, did not meet with the anticipated success.

This experience led to the construction of an apparatus for making photographic records of the vibrations of a Bell telephone disk, which is equally applicable to other vibrating membranes.

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[1] This difficulty is especially illustrated in the reproduction of sounds by the phonograph, each jar or irregular movement of the cylinder being recorded upon the tin-foil to the detriment of the proper sound tracing; by careful construction of the bearings of the shaft, this is being overcome.

[2] "The Use of the Human Membrana Tympani as a Phonautograph and Logograph," C. J. Blake, Archives of Ophth. and Otol., 1876.

[3] Poggendorf's Annalen, Bd. CLIX., S. 142.

A plane mirror of steel is supported by its axis in a metal frame, the ends of the axis being conical and accurately fitted into sockets in the ends of two screws; on the back of the mirror is a slight projection pierced by a small hole, one end of a stiff steel wire bent at a right angle fits into this hole, the other end of the wire being attached to the centre of the telephone disk, the mirror being set with its axis parallel and its reflecting surface perpendicular to the vibrating disc.

A heliostat sends a beam of light horizontally through a small circular opening; this beam passes into a dark closet, and at a distance of several feet from the circular opening falls upon the mirror placed with its axis inclined 45° to the horizon.

The rays, reflected vertically downward, pass through a lens, at whose focus they form an intensely luminous image of the circular opening upon a sensitized plate placed upon a carriage moving horizontally at a uniform velocity.

On speaking into the mouth-piece the disk is set in vibration, each movement causing change of angular position of the mirror, the reflected light moving through twice this angle and the resulting photograph giving the combination of its motion with that of the carriage.[1]

The tracings obtained by this method differ materially in their appearance from those afforded by any form of graphic apparatus. They suggest a nearer approach to the accurate representation of sonorous vibrations, and being produced with the minimum loss of power and presenting a magnified tracing without resort to mechanical device for enlargement, would seem to offer the best means for the analysis of articulate speech.

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[1] "A Method of Recording Articulate Vibrations by Means of Photography," E. W. Blake, Jr., Hazard Professor of Physics, Brown University, Am. Jour. Science and Arts, July, 1878.

(To be continued.)

TWENTY CASES OF THE GROWTH OF ASPERGILLUS IN THE LIVING HUMAN EAR.

By CHARLES HENRY BURNETT, M.D.,

PHILADELPHIA.

My apology for presenting this paper must be that clinical observations are always of value, whether they are confirmatory of the researches of others, or expository of the features of a disease and of simpler modes of treatment.

Although many of the readers of this account of the growth of a fungus in the ear—and I use the word fungus in purely a botanical sense—will be familiar with the literature pertaining to the subject, it will not be out of place to recall some of it, both to refresh our memory and to help those who have not had access to works setting forth the nature of this parasite as it shows itself in the living human ear.

It is to Wreden, of St. Petersburg, that the profession looks for the most voluminous account of the growth of this fungus in the ear, and of the aural disease produced by it, to which Wreden has given the very appropriate name of *Myringomycosis aspergillina.*[1]

The first observations of the growth of a fungus in living animal tissues were made by German and French writers, in the first half of this century, according to the work of Wreden already alluded to. These writers based their statements on what they found in the lungs and air-vesicles of birds. Virchow[2] too observed fungi, perhaps the aspergillus, growing in the lungs of man.

The first proof of the development of fungi in the ear of living man was given by Mayer,[3] and subsequently by Paccini;[4] still later by Carl Cramer[1] and Schwartze.[2] It is highly probable that the cases thus reported were of aspergillus. Wreden's[3] first article on the subject appeared a year later than Schwartze's, and gave an account of six cases of the growth of aspergillus in the human ear. The species found were characterized by him as of the A. glaucus, Lk.

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[1] See his work, "Die Myringomykosis Aspergillina." St. Petersburg, 1868.

[2] Virchow's Archiv, Bd. IX., Heft 4, pp. 557–80.

[3] "Beobachtungen von Cysten mit Fadenpilzen aus dem äusseren Gehörgange." Müller's Archiv, p. 401, 1844.

[4] Supra una Muffa parasita (Mucedo) nel condotto auditivo. Florence, 1851.

Then followed communications on this subject from numerous sources in Germany and in the United States: in the former country from von Troeltsch, Böke, A. Politzer, J. Gruber, Weber-Liel, Bezold, Lucae, Nölting, and others; and in our own land, from J. Orne Green, Roosa, C. J. Blake, and myself.

The vast majority of these communications have related to the aspergillus, although there have been some interesting exceptions which appear worthy of mention here.

Hassenstein and Hallier claim to have found in the ear of man the *Graphium penicilloides;* von Troeltsch, the *Ascophora elegans;* Schwartze and Steudener, the *Tricothecium;* Böke, the *Mucor mucedo seu fuscus;* and Blake, a bastard form of *Penicillium.* Wreden,[4] in one instance, found the most fully developed or ascomycete form of the Aspergillus nigricans, which from its intense purplish color he called, for the time, the *Otomyces purpureus*, but which on examination was not found to be a separate species of aspergillus; and Dr. J. Orne Green[5] has described a form of *Aspergillus rubens*, in which the fungus was, as indicated by the name given it, of a red color.

But all of these forms of fungus are of unfrequent occurrence, and would by their bluish or purplish color easily attract attention and at once indicate their nature as not that of ordinary aspergillus.

The Aspergillei belong to the division of the Fungi called Arthrospores. In the same division are other fungi which at times become parasites of living man, viz.: the Tricophyton, the Microsporon, the Achorion, and the Oïdium.

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[1] Sterigmatocytis autacustica, a variety of Aspergillus. Vierteljahrschrift d. Naturforscher Gesellschaft zu Zurich, 1859–60.

[2] Archiv f. Ohrenheilkunde, Bd. II., H. 1, p. 5, 1865.

[3] Ibid., Bd. III., H. 1.

[4] Archives of Oph. and Otology, 1874.

[5] Proceedings of Boston Society of Medical Sciences.

The Aspergillei form a family by themselves, according to Léveillé, having, according to Charles Robin, eight species. Some of these species have been found in tuberculous lung, notably in the lungs of birds, though also in that of man. To us, however, the most interesting species are those found growing in the auditory canal, and on the membrana tympani of living man.

This is no uncommon occurrence, yet doubtless it is not usually recognized, although exciting an inflammation of a decidedly peculiar form. Even the late Mr. James Hinton, of London, stated that he had not met it in his enormous practice, and doubted its existence in denizens of cities.

Dr. J. Patterson Cassells, of Scotland, is the only British writer on the observation of the growth of this fungus in the ear of living human beings.

Aspergillus is a form of mold, and shows a decided tendency to grow in the ear of man. It is believed by some to be ordinary mold modified by growing in living human tissue. It is not, however, identical, either macroscopically or microscopically, with the ordinary blue or green mold. From my observations I am inclined to believe that the Aspergillus found in the ear of living man is, as Wreden has termed it, the specific aural fungus. One thing seems fully settled: that the fungus is not found anywhere else in forms similar to those which flourish in the ear both of the lower animals and of man.

Two forms have been found in the ear of man, and have been called the A. glaucus and the A. nigricans.[1] But these terms do not recommend themselves as apt, because the color of the fructiferous hyphens, on which these names are based, is neither invariable nor decided enough to render this nomenclature distinctive.

It seems to me that the terms *major* and *minor* would be preferable to *nigricans* and *glaucus* respectively. Here let me say I am speaking simply as a diagnostician of aural disease, and not as a botanist or mycologist.

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[1] **Some writers give also an *A. flavescens*, but this is probably a term based on a different shade of color in the A. glaucus.**

The so-called A. nigricans is by far the more common in its occurrence in the ear of man, and is larger in size than the A. glaucus, which is rarely found in the ear. As will be seen by referring to the cases I present, the A. nigricans was found in all.

These forms are easily distinguished from each other by the shape of their fruit-heads and the arrangement of the sterigmata thereon, and on these differences I would like to base their nomenclature. So far as their color is concerned, it is wholly unreliable as a diagnostic difference; in no instance is their color either clearly green or black. In all cases of ordinary aspergillus the color is yellowish or brownish. It has never been shown that one form excites an inflammation different from that produced by the other; but it may yet be shown to be of the highest importance in diagnosis to have for these fungi a definite name, for in whatever form they manifest themselves in the ear they excite a stubborn and painful disease.

For the sake of uniformity and order, I shall retain the names A. nigricans for the *larger* and A. glaucus for the *smaller* species.

Microscopic features.—The microscopic features of the growth of this parasite in the human ear are varied and full of interest. If a small piece of a colony of aspergillus nigricans, in the earliest stages of its development, be examined under the microscope with a power varying from 250 to 300 diameters, a field similar to that in Fig. 1 will be observed. It is in fact the first formation of rootlets or the mycelial web from which, at a later period, the fruit-stalks or fructiferous hyphens spring. It will also be seen that some of the filaments composing the web tend to become bulbous at one end, and that the latter, as the stem grows, becomes larger and dotted (Fig. 2), until finally there is standing out from the dense web of mycelial filaments a perfect fruit-stalk and a fructiferous head—the latter studded with short peg-like limbs, the sterigmata, on the free ends of which are the spores. (Fig. 3, B.)

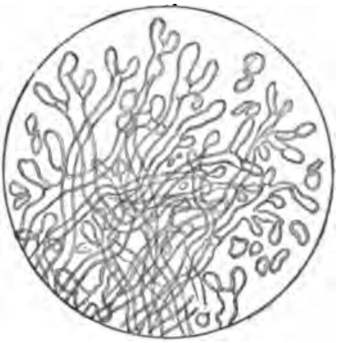
FIG. 1.

All of these stages of growth I have traced in specimens of the fungus removed from the human ear. In the fluid parts of the specimen, epithelium may usually be seen, in small quantities, as the parasite develops, as in the upper part of Fig. 2.

Very rapidly, in the course of a day or two at most, the perfect fruit-stalk is formed in large numbers and in all stages of development, and the mycelial filaments can be seen to be coarser and septate. On one hand may be seen a well-formed though unripe fruit-stalk and head (Fig 3, B.), while in the centre of the field there may be seen the ripe aërial fruit, from which the fully grown spores drop, literally in myriads. (Fig. 3, C.)

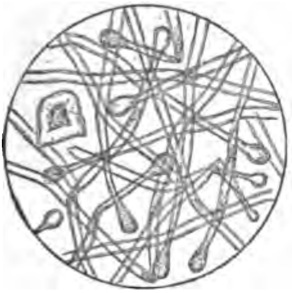
FIG. 2.

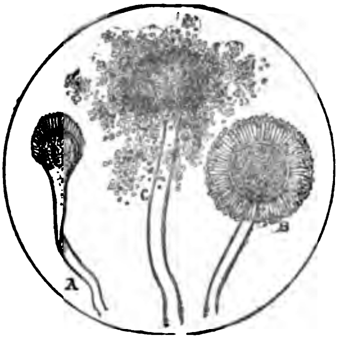

FIG. 3.

The characteristic difference between the two varieties of aspergillus, the so-called *yellow* and *black*, is seen in the shape and size of the *receptaculum*, and the arrangement of the *sterigmata* upon it, these two parts forming the so-called "head" or *sporangium*.

In the *A. nigricans* (Fig. 3, B.) the sporangia or heads are distinguished from those of the *A. glaucus* (Fig. 3. A.) by the fact that in the first the sterigmata cover the receptaculum, which is spherical, on all sides, while in the latter, the lower fifth or fourth of the receptaculum, which is ovoid in shape, is entirely free from sporangia.[1]

Of the latter variety I have seen but one specimen, which, however, I did not remove from the ear. It was given to me by my friend and instructor in Heidelberg, Prof. Moos, who had removed it from the ear of one of his patients. The specimen I mounted in glycerine in the winter, 1870–71, and still retain it in the same perfection in which I received it. Although there is some oleaginous matter, in which the fungus was found in the ear, still adherent to the specimen, there is no evidence of germination; yet it has been thought by Wreden that, in one instance in which aspergillus from the ear had been preserved in glycerine, germination went on to some extent.[1] In no instance have there ever been, in cases observed by me, any evidences of continued growth of this fungus after it had been placed in glycerine for preservation. But small portions of the mycelial web or of the fungous mass, as it comes from the ear, will, if placed in a glass box, continue to grow and to retain the microscopic appearance of Aspergillus nigricans.

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[1] **See Wreden, Archives of Ophthalmology and Otology, 1874.**

From the fact of this retention of form, it would seem that this is a specific fungus, and not ordinary mold modified by growing in the ear.

It may be said, then, that in general there are found, with the aid of the microscope, four distinct elements in a fungous mass of aspergillus taken from the human ear, viz.:

1. The mycelial web, composed of the so-called tubules, rootlets, or filaments.
2. The fruit-stalk or hyphen, and
3. Its head or the sporangium.
4. The free spores.

The first, the filaments or tubular rootlets, are composed of sections, and are hence described as septate. The component cellules are from 0.020 mm. to 0.090 mm. in length.

The fertile hyphens or fruit-stalks vary in diameter from 0.009 mm. to 0.013 mm., and their length is 0.770 mm. These terminate in the so-called *receptaculum*, the placenta of Micheli, which has a diameter of 0.028 mm. (Robin.) On this grow the sterigmata and spores, the three together forming the so-called capital or head, 0.060 mm. in diameter, the third of the elements named above.

The spores are spherical, and measure 0.003 mm. in diameter. By careful fine adjustment of the lens, their surface is seen to be echinate. Some idea of the immense number of these spores in any case may be gained by Pacini's estimate, quoted by Robin, that there are *nineteen thousand* spores on each fruit-head.

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[1] "Die Myringomykosis," p. 6, Case II.

Macroscopic features.—The macroscopic appearances of a mass of this fungus, as found in or washed from the ear, are worthy of attention. For, although the microscope must in every case decide the presence of aspergillus in a suspicious object coming from the external auditory canal, nevertheless the macroscopic features of a plug or membrane composed of this aural fungus are of a nature to lead the surgeon to suspect that he has to deal with a case of aspergillus in the ear. If an ear containing a mass of aspergillus be examined by means of an ear-mirror and ear-funnel, it will present most usually an appearance which leads to the supposition that the ear is occluded not by wax, but by a foreign matter of an organic nature.

If the fungus has not been growing long in the ear, merely a patch of pale yellow, pollen-like matter, of varying diameters, will be detected at the fundus of the auditory canal. This small colony of spores just developing into filaments, for such it is, is usually situate on the membrana tympani, or very near it. In any case, whether the first deposition of spores occurs there or not, the tendency of the aspergillus is to grow over the drum-head first, and from that point it spreads outward, covering the wall of the meatus, until a hollow cast of the canal is formed by the vegetable parasite. The pollen-like appearance is seen only in the very earliest stages of a growth of that which is finally a so-called lardaceous-looking or false membrane, either partially or entirely filling the external auditory canal.

In some cases the fungous mass looks like a ball or plug of wet newspaper, and in others the ear may seem to be plugged with a substance looking like wool. An inexperienced eye might conclude that the occluding plug thus formed is of ear-wax; but ear-wax looks more solid, shining, and drier, and it never excites pain and inflammation in the ear like the fungus aspergillus.

Another important point in differential diagnosis is that a mass of aspergillus does not lose its coherence when subjected to immersion in water or glycerine; but a lump of ordinary hardened cerumen soon melts, and is diffused throughout the water or any other fluid in which it is allowed to lie.

Finally, the microscope would immediately show whether such a mass washed from the ear were aspergillus, or the peculiar laminated, epithelial plug, the so-called *Keratosis obturans* of Wreden.

The consideration of the symptoms, etiology, and treatment of the disease produced by the aspergillus in the ear will be deferred until after the recital of the cases.

CASE I.—*Aspergillus nigricans in the tympanic cavity.*—Miss M., eighteen years old, living in the best of hygienic surroundings, consulted me on October 10, 1872, respecting a chronic discharge from her right ear, attributed by her family to teething, since which time it had existed.

Upon inspection, a not copious, light greenish, purulent and odorless fluid was found in the fundus of the right auditory canal. The membrana tympani was destroyed, excepting small, crescentic portions on a level with and extending backward and forward from the short process of the malleus. The manubrium seemed shorter than normal, probably by foreshortening from the retraction the remnants of the drum-head must have undergone. The hearing for the watch in the affected ear was reduced $\frac{3}{60}$ $\frac{\text{in.}}{\text{ft.}}$ to Under the use of astringents and daily syringing the chronic purulent discharge ceased, the membrana tympani was not restored, but the mucous membrane of the tympanum became dry, pale, and shining, and did not appear thickened.

About the 4th or 5th of July, six months after the healing of the ear as above described, the patient, while at her father's country-seat, took a bath in cold spring-water, and while in the bath voluntarily splashed cold water against the side of her head and into her previously diseased ear. This act was instantly followed by a sharp pain in the right ear, which, though not lasting long, was followed by a bloody discharge, the first escape of fluid of any kind from the ear since it was healed in the previous December.

The patient consulted me on the 7th of July, when the membrana tympani was found still further gone than when I last saw it, there being but a peripheral rim, and in place of the manubrium of the malleus there was a short, pendulous and movable body resembling the manubrium, which, by means of a probe, could be swung about in any direction without pain to the patient. The mucous membrane of the inner wall of the tympanum, as far as was seen, was thickened and very red, but the auditory canal was *entirely normal.*

A slight, purulent discharge came from the middle ear. The patient was ordered to syringe the ear and use instillations of a two-grain solution of sulphate of zinc, thrice daily, under which the discharge ceased. But in about a month, *i. e.*, in August, 1873, the patient came to me with the statement that her ear was discharging again, but this time the matter was *different from any she had ever noticed before, as it was thin, transparent, and almost colorless.* It was then found that a pale yellowish, serous fluid was coming from her ear in small quantity, that the external auditory canal was entirely free from disease, that the tympanic cavity was congested, but that there was no pain nor pricking in the ear. The Eustachian tube was entirely pervious. The use of astringents and syringing was resumed and faithfully carried out by the patient, but, in spite of a variety of astringents both in weak and in strong solutions, the same thin, watery discharge continued from the ear. There was no pain nor itching, excepting when the astringents were put into the ear; then itching would be felt for half an hour sometimes.

The most that this treatment accomplished was a temporary cessation of the serous discharge for a week or two at a time, but it kept returning. It never grew any worse, but it never became materially better.

At last, on the 25th of May, about *nine months* after the first appearance of the watery discharge, the patient brought me a suspicious-looking pellicle, with dark brown spots on it, which she said she had syringed from her ear, stating also that it was similar to others she had at times taken from her ear, but of which no mention had ever been made to me. Portions of this spotted pellicle were examined with the microscope, and found to be composed of a dense mycelial web, with the aërial fruit and free spores of the *Aspergillus niger.*[1] The patient also informed me that she had removed similar spotted pellicles from her ear by means of a hair-pin, and she offered to make good her statement to this effect, then and there, if I would permit it. As I had just examined the ear, and found by inspection nothing that resembled the false membrane of aspergillus, curiosity as to whether and how she could produce a specimen of the fungus from her ear by this means led me to consent to her proposition. After she had bent a hair-pin at its curve into a miniature retractor, she passed it into her tympanic cavity, then turning her hook upward and backward toward the mastoid antrum, she skilfully and quickly made a gentle turn with the instrument, then withdrew it, giving herself no pain, and succeeded in removing, as she had said she could, a spotted pellicle similar to that described. Instantly this was examined under the microscope, and the aspergillus nigricans was found in various stages of development.

Here, then, was aspergillus *growing far in the tympanic cavity, and that, too, in the region of the tegmen tympani and the mastoid antrum.*

Treatment.—The patient was then told to use three daily instillations of absolute alcohol, or rectified spirits of wine, in the affected ear, and to syringe the ear most thoroughly and carefully with warm water. Several days later the patient was seen, and it was found that numerous pellicles were coming from the ear, containing all the elements of aspergillus, but fewer free spores. The alcohol was found to have produced some burning when first applied to the ear, but subsequently this discomfort was not induced by its use.

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[1] Mistakenly reported as A. glaucus in the account of the case given in the Transactions of the International Otological Congress, N. Y., 1876.

In these later specimens of aspergillus from the ear there were found imbedded beautiful octahedral crystals, now supposed to be from the liquor potassæ used in preparing the specimen for the microscope. Under the treatment of the ear with alcohol instillations the watery discharge ceased, the aspergillus did not reappear, and the case was dismissed as cured.

In this, it may be said rare case, the fungus was not observed at any time in the external auditory canal, but apparently sprang up in the tympanic cavity, in parts invisible to the observer from without. Since, in an ear in which the membrana tympani is intact, the aspergillus always seeks the deepest parts of the externa auditory canal, and grows on the membrana tympani, it can easily be comprehended how, if this fungus attack an ear in which the membrana tympani is destroyed, the vegetable parasite, in its endeavor to find a secluded spot for growth, would spring up in the tympanic cavity rather than in the external auditory canal.[1] This same instinct of seclusion would also incline the aspergillus to seek those parts of the tympanum not easily visible or reached by the surgeon from without, as, for example, the inner surface of the remnant of the membrana tympani, the tegmen tympani, and the region of the mastoid antrum.

The only symptom of aspergillus in this case, until the spotted pellicles were found, was the thin, watery, serous discharge, which, however, might occur without the presence of aspergillus in the tympanum; unless it be found that the chronic, slight, serous discharges from the tympanum, which sometimes occur in cases where the membrana tympani is destroyed, are due to the unsuspected presence of aspergillus within the tympanic cavity.

In this case it must be supposed that the fungus either existed prior to the time I first saw the patient, or that it sprang up during the time she was under treatment for chronic discharge from the ear. The purulent nature of the discharge would exclude the first supposition, as purulent discharges are not found in connection with the growth of aspergillus in the ear; nor is it likely that the fungus sprang up in the ear while the patient was under treatment for chronic purulent discharges from the ear, since all aurists are agreed that usually thorough cleansing of the ear by syringing is sufficient to remove fungi from the ear. It is not probable, therefore, that the fungus developed in the ear while the patient was under treatment for aural discharge, prior to August, 1873.

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[1] For instances of the growth of aspergillus in the tympanic cavity, see Wreden, "Die Myringomykosis Aspergillina." St. Petersburg, 1868, pp. 24, 25, and p. 47; Politzer, Wiener Med. Wochenschrift, No. 28, 1870.

It will be remembered that the patient was attacked with pain and renewal of the old purulent discharge after an accidental entrance of cold water into the ear, in July, 1873, and that this was cured. Between the time of this cure and the outbreak of the serous discharge, a month elapsed. During this month the fungus attacked her ear, just as it, in so many other cases, invades an ear that has been, but is no longer, the seat of active inflammatory disease. In such cases enough dead animal matter exists to invite the saprophyte, and to this, it seems, this patient owes her experience of the growth of aspergillus in the ear.

Case II.—*Aspergillus nigricans in the left auditory canal.*—The patient, Mrs. W., forty years old, applied to me, September, 1873, for treatment of hardness of hearing and ozæna, from which she had suffered for several years. In addition to this, as I learned subsequently, she had experienced numerous attacks of sudden and sharp pain in her left ear. The attacks lasted but a day or two, and were then followed by a slight watery or serous discharge from the affected ear. It was just after one of these attacks had ceased that I examined the left ear and removed a cast of the external auditory canal and drumhead. Before the removal of this cast from the meatus auditorius, the auditory canal, especially at its fundus, appeared lined with a piece of wet newspaper. This will best describe the appearance of the bottom of the canal before the removal of the fungous false membrane. As I had examined the ear for another purpose ten days previously, I knew that the fungus had formed within that time. By means of a pair of curved forceps, light being reflected into the meatus by means of a forehead mirror, the outer edge of the cast was seized and removed without any pain to the patient, for the mass of fungus was not adherent to the walls of the canal.

The walls of the auditory canal and the membrana tympani were thus exposed to view, but were not unusually red or sensitive. A drop of fluid taken from the auditory canal, and immediately examined under the microscope, revealed the presence of numerous free spores of the aspergillus nig. and also numerous vibriones. There were, however, no pus-cells in the fluid thus taken from the meatus of the ear. The cast of the fundus of the auditory canal proved to be composed of mycelium richly studded with colonies of hyphens supporting large and beautiful sporangia of a dark brownish or blackish color. The hyphens were not septate, nor was there a membrane enclosing the sporangia. Imbedded in the mycelium there was a little epithelium, and scattered over it were myriads of free spores. The thalli were septate, and here and there I detected a little spot of bright green coloring matter in them. The spores were echinate. Though at that time I thought this was aspergillus glaucus, I now know that it was the A. nigricans.

Treatment.—The treatment in this case consisted of three instillations of a solution of nitrate of silver (100 gr. to f ℥ j.), within the first ten days, and the repeated daily use of instillations of alcohol (90 per ct.) for one month. There was no return of pain, and the ear assumed its normal appearance in a few weeks.

So far as etiology is concerned, it may be said that this patient was living in a damp house, the cellar of which was moldy.

CASE III.—*Aspergillus nigricans in the right auditory canal.*—General ——, of Conn., sixty years old, came under observation May 21, 1875, for chronic purulent disease of *right* ear, with perforation of the membrana tympani about the tip of the manubrium, and with thickening and cicatrization of the *left* drum-head in consequence of purulent otitis media on that side, the disease of both ears dating back to early life. There had been a gradual loss of hearing, and the patient had suffered from vertiginous symptoms and depression of spirits of late years. The chronic discharge was treated by syringing and the use of zinc drops, 5 grs. to f ℥ j., without much benefit, as I learned subsequently by letter. On October 9, 1875, I saw the patient again. The subjective symptoms in the right ear had apparently changed since our last interview, for there were now experienced heat, pain, and fulness in the ear. The left ear remained as it was, being relieved from time to time by Valsalva's inflation. Upon inspection of the right ear by means of the aural mirror and funnel, it became very apparent that a false membrane had formed around and over parts of the membrana tympani and walls of the auditory canal. These being washed away, the membrana tympani was found red, swollen, and sensitive. The microscope having decided the true nature of the false membrane in the ear, as being composed of aspergillus nigricans in various stages of development, the patient was ordered to syringe the ear three times daily, and to instil into it absolute alcohol, allowing the latter to soak in the ear a minute. The alcohol applications burned a little, but caused no irritation.

By October 20th the ear was better, but not well, the patient having neglected to syringe the ear. But after this treatment had been carefully kept up until November 3d, all discharge ceased, there was no trace of the parasite, and the membrana tympani had become thin, pale, and shining, the perforation in it still remaining. Syringing with warm water was kept up in this case until December 1st, when the patient was entirely able to cease all treatment, and then passed from further notice.

Here is another case in which aspergillus was found in an ear, the membrana tympani of which was perforated. There was a history of a very chronic discharge, of varying quantities, which, however, was checked by a rather short treatment of a parasiticidal nature. It looks as though the presence of aspergillus had been the chief and protracted, though unsuspected, cause of the chronic discharge. Although at times a catarrh may have caused the ear to run, still the aspergillus, with its pertinacity, hung about the ear and kept up the irritation and running. In some such way the great and prompt efficacy of alcohol, in some cases of so-called but vaguely termed otorrhœa, may be accounted for.

CASE IV.—*Aspergillus nigricans in both auditory canals.*—Mrs. S., of Philadelphia, thirty-five years old, came under observation November 11, 1875. The patient was living in perfect hygienic surroundings, and led a life of ease. Her general digestion was deranged, she being what is termed of a bilious temperament. She stated that for several weeks her ears had itched and become more and more uncomfortable to her, until at last they had grown painful, very tender to the touch and burning, and that at last they had broken out and a disagreeable and irritating, though scanty, watery discharge, had come from each ear. On examination, well marked acute eczema of the auricles was seen to be present, and the meatus was plugged up with gray, damp masses of epithelium. Upon syringing out the ears, each membrana tympani was found obscured with whitish flakes, and the walls of the canals were more or less broken by the scratching of the patient. The hearing was dulled. The microscope revealed the presence of the aspergillus.

Treatment.—The treatment was necessarily mild, on account of the abraded and eczematous state of the ears. It consisted in my thoroughly cleansing the ears and in dusting over the eczematous concha and meatus a powder composed of equal parts of Hubbuc's oxide of zinc and starch. For the dyspeptic symptoms, Huxham's tincture was taken and relief was obtained. In twenty-four hours the eczema had greatly subsided and the ears felt much more comfortable. The canals were still red, and at spots on the lower wall the skin was fissured. I saw the patient every other day and powdered the ears as above stated, obliging the patient to leave the powder in the ears, and I removed any flakes or scales which might have formed in the canal. The membrana tympani gradually became more healthy in appearance, and the glandular swelling about the ear went down. On the 17th of November I found around the meatus of the left ear a fresh growth of aspergillus. It had sprung up very near the opening of the canal, and its peculiar fuzzy or downy appearance was visible to the naked eye. The color was slightly yellowish, and any one looking closely at the ear would have been attracted by the appearance of this formation at the mouth of the canal. This was removed by gentle scraping, and the ear syringed with alcohol and water. The ear was closely watched and the eczema combated by mild means, and by December 1st all traces of aspergillus had disappeared. A little pruritus still annoyed the patient, but this was allayed by warm water.

Etiology.—In this case the patient said, on being closely questioned, that the earliest feeling which attracted her attention to her ears was itching, to relieve which she had scratched her ears inordinately with hair-pins. Here the means of ready abrasion of the skin was offered, and gradually a soil composed of minute portions of dead skin, serum and blood was provided for the fungus, which lost no time in settling on the ear. This of course produced more discomfort and itching, to relieve which the fingers and the hair-pin were again employed, eczema was gradually excited, and the ear started on the vicious circle so often seen in cases of aspergillus in the ear. It is indeed difficult to say, in some cases, whether the first irritation felt in the ear is due to the presence of the aspergillus, or whether the ear begins to itch from some ordinary cause, and then, being unduly scratched and abraded, the aspergillus finds favorable soil for development; but I am inclined to the latter view.

CASE V.—*Aspergillus nigricans in the left auditory canal.*—Mr. E. C. A., of Buffalo, N. Y., twenty-eight years old, merchant, came under observation September 8, 1876. The patient was led to seek relief from excessive pain in the affected ear—in fact, the fungous growth produced much more pain in this case than in any I have observed. The concha and meatus were excessively tender and inflamed, and from the mouth of the canal a dark object was seen projecting. The hearing was greatly reduced. By syringing, large lumps of what was found to be masses of aspergillus were washed from the ear, but the membrana tympani was covered by an adherent grayish false membrane of fungous mycelium.

Treatment.—In this case the patient was advised to instil absolute alcohol into his ear thrice daily, but not to use the syringe; and this method of treating aspergillus in the ear I have found very satisfactory. The alcohol kills the parasite and causes all adherent parts to become detached. These can be syringed out by the surgeon every day or two, but the use of the syringe on the patient's part, in such cases, is better dispensed with, as it has often seemed to irritate the ear.

Etiology.—The etiology in this case is obscure. There was history of ear disease for which the patient had been treated in his own city and for which nitrate of silver had been used, which, in all probability, had stained the masses of aspergillus, for all the fungus in this case was abnormally black, looking like black wool, as it came from the affected organ. Under the microscope the blackness was shown to be due to artificial causes. In four days, by the use of the above-named treatment, the fungus disappeared from the ear and the membrana tympani became shining and lustrous.

CASE VI.—*Aspergillus nigricans in the right auditory canal.*—Miss A., of New York City, thirty-five years old, came under observation September 16, 1876, with a card of introduction from Dr. Roosa, who had found aspergillus in the right meatus. On close examination of a small pellicle removed from the left external auditory canal, I found a few fruit-heads of the aspergillus. There was no inflammation of the ear in this case, but only a slight itching.

Treatment.—There was no local treatment in this case, but the patient being a little run down from visiting the Centennial Exhibition, iron and quinine were administered with good effect. There was no return of aspergillus in this case as long as she was under my observation. Here again the aspergillus was found in an individual living in the best of circumstances.

It is interesting to note that the parasite may grow in small quantities in the ear without exciting local inflammation. This patient had suffered from pruritus of the auditory canals, and if rough scratching had been indulged in, it is probable that the fungus would have had more encouragement than it received, to extend its growth.

(To be continued.)

SYPHILITIC AFFECTIONS OF THE EAR.

By **ALBERT H. BUCK, M.D.,**

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To judge from the accounts of recent writers on otology, and from my own experience, cases of syphilitic disease of the ear are quite rare. Thus, upon searching through my records of cases from March, 1870, to the present time, I find that I have seen only 30 cases of disease of the ear in which the functional or organic disturbances could fairly be attributed to syphilis.[1] These figures, however, must not be accepted as furnishing a correct measure of the share which syphilis takes in the production of diseases of the ear. I have no doubt that the percentage is in reality much larger, but the difficulty of recognizing the syphilitic element in the case, and the habitual practice of such patients to conceal the fact of their having contracted this disease, render it an easy matter for the physician to err in his diagnosis and to overlook many cases which really belong under the head of syphilis. The scantiness of the material, however, is not the only thing which makes it difficult for the physician to gain a satisfactory knowledge of syphilis as it affects the ear. Infirmary patients, who supply the chief quota of cases of aural syphilis, visit the institution as a rule only once or twice. They are very apt, also, not to seek relief until the affection has made decided progress. One can readily appreciate, therefore, how fragmentary and disconnected the observations made upon this sort of material must be. Then, too, the records themselves are often very imperfect. With a single assistant and sometimes a large number of impatient patients, it is not an easy matter to record all those points which should be recorded. At the same time even fragmentary pictures of disease may prove of value; they sometimes supply a missing link, and at all events they often spur up others to study and report their own cases. As such a fragmentary contribution, then, the following reports of cases and running comments are offered.

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[1] **Thirty out of a total of 3,976, or a little over three-quarters of one per cent.**

Among the thirty cases referred to above, I find only two in which the auricle was the seat of pathological changes that could fairly be considered as pathognomonic of constitutional syphilis. They are the following:

CASE I.—Male, ætat. 26, May 27, 1874. Syphilis (primary) four years ago. Sore throat and eruption on face last December. Three weeks ago he began to have some pain in the left ear, without tinnitus or noticeable deafness. During the past week the pain has been more pronounced, and there has been a slight discharge from the outer canal. Tragus and outer portion of meatus red, swollen, and tender, especially superiorly. Deep ulceration of the auricle at the commencement of the fossa helicis, just above the orifice of the external auditory canal. It measures fully half an inch in diameter, and extends down to the cartilage.

The ulcer was cauterized with the stick of nitrate of silver, and three leeches were applied in front of the tragus. (Patient did not return.)

CASE II.—Male, ætat. 32, in rather poor physical condition, June 16, 1875. He is now suffering from syphilitic disease of the nasal bones or cartilages, the contour of the nose being already disfigured. A large part of the fossa helicis of the auricle is occupied by a dry scab, from beneath one edge of which a little pus escapes. The removal of this scab brought to view a roundish ulcer about the size of a three-cent piece. The ulcerated surface, which was not depressed below the surrounding surface of healthy skin, seemed to be composed of a soft, succulent tissue, in places apparently papilliform in structure. A single application of a saturated solution of nitrate of silver caused the ulcer to heal entirely in the course of a few days. It should be stated, however, that the patient had been taking iodide of potassium for some time previously.

The following three histories are descriptive of lesions located in the external auditory canal:

CASE III.—Male, ætat. 44, April 8, 1874. Patient "caught cold," as he thinks, three weeks ago. One week ago his left ear began to ache, and the same day he noticed a discharge from the left meatus. Since then there has been a constant discharge. On examination, the left membrana tympani is found to be red, very much swollen, and perforated anteriorly and inferiorly. The lower wall of the outer half of the external auditory canal is ulcerated for a distance of about half an inch. The ulcer extends outward upon the auricle, and has quite well-defined limits. Pharyngeal mucous membrane characteristically red and swollen (syphilitic pharyngitis). Chancre one year ago. (No further data.)

CASE IV.—Male, ætat. 28, of strong frame and apparently vigorous constitution. He states that in February, 1878, he first noticed a discharge from the right ear. It came on without any pain, lasted for a few weeks, and then stopped of itself without treatment. In the early part of the summer the discharge returned and has persisted up to the present time (Aug. 7th). Of late there has also been some soreness of the ear. No noticeable deafness. Examination of the ear reveals the following condition: The orifice of the meatus is almost completely obliterated by the presence of an elevated patch of what seems, at first sight, to be granulation tissue. The dividing-line between this patch, which completely encircles the orifice, and the healthy skin of the auricle, is sharply drawn, the edges of the elevated portion being quite abrupt. A watery discharge oozes from the lower part of the granulating surface. By pulling upon the auricle upward and backward, a narrow orifice with jagged edges is brought into view at the centre of the mass of granulations. Upon a closer inspection, this apparently granulating surface was found to be in reality a mass of minute vegetations or papillomata, most of them being of a pale pinkish hue, but a few of a very bright red color. At the actual orifice of the meatus, some of these growths were found to be quite large in comparison with the greater number—as large, *e. g.*, as a hemp-seed, or even larger. The external auditory canal itself, so far as the eye could see with the aid of a small speculum and reflected light, was filled with similar vegetations. Between the larger masses were numerous smaller and more pointed growths, like those observed at the orifice. The membrana tympani was of course invisible. When touched with the probe, the larger of these growths were found to be considerably harder than ordinary granulation tissue. Some of them looked precisely like the warts seen on the fingers of young children, the skin covering them being pale and tough like natural skin. The smaller papillary growths, and one or two of the larger ones near the orifice, were less firm in structure, and bled readily when manipulated with the probe. The gland lying upon the mastoid process of the same side was enlarged to such an extent as to cause a visible swelling in this region. The occipital glands were also moderately enlarged. A diffuse discoloration of the skin, with desquamating surface, was observed on the hairy scalp, and also to a slight extent on the forehead of the left side. Two well-marked " mucous patches " occupied the left half of the velum palati. On questioning the patient, it was ascertained that he had contracted the primary lesion about fifteen months previously.

Treatment was not begun until September 4th, when he was given the oleate of mercury (Squibb's), a drachm to be rubbed into the skin every night, and the bichloride of mercury, one thirty-second of a grain to be taken internally three times a day. The ear to be syringed twice a day with lukewarm water. The larger vegetations which were within reach were snipped off with the scissors; the smaller ones were touched with nitric acid.

Sept. 26. The dose of the bichloride was increased to-day to one-sixteenth of a grain three times a day. The patient was also given some calomel with which to dust those vegetations which were within his reach.

Oct. 2. Patient feels better in every way, and says that the otorrhœa is diminishing in quantity. The patch of vegetations around the orifice of the external auditory canal has perceptibly diminished in height and in vividness of color.

Oct. 23. Patient has gained thirteen pounds in weight since the 4th of September. He has been very faithful in using the remedies prescribed. The squamous eruption on his forehead has almost disappeared. The orifice of the external auditory canal has been steadily increasing in size. Very little change, however, is perceptible in the condition of the deeper portions of the canal. By aid of the probe it was ascertained to-day that the innermost section of the meatus, close to the membrana tympani, was smooth and apparently free from vegetations. The "mucous patches" are still visible on the velum. Iodide of potassium is to be added to the bichloride mixture in the proportion of ten grains to each dose.

Nov. 6. The wart-like growths in the external auditory canal have become less prominent; they encroach less upon the calibre of the canal, and the intermediate bright-red pointed condylomata have lost their bright color and well-defined outlines. Nitric acid (undiluted) applied firmly to one of the more prominent excrescences near the external orifice. The pain which followed lasted but a minute or two, and then entirely disappeared. Appetite good. No evidence of sponginess of the gums.

Nov. 13. Application of nitric acid repeated to-day. The orifice is now increasing in size quite perceptibly, and the deeper condylomata—simply under the influence of the constitutional treatment—have now shrunk away to mere elevations of the skin. The discharge is also very much less than at first. The inunctions are still kept up. The improvement in the condition of the meatus has been more marked during the past week than during any previous week since treatment was begun. No appreciable change in the condition of the "mucous patches" on the soft palate. Dose of potass. iodid. increased to twenty grains three times a day.

Nov. 20.—Patient has now gained twenty-six pounds in weight. The discharge from the ear has ceased, and almost every trace of the condylomata has disappeared. Membrana tympani entire. (Case still under observation).

Case V.—Female, ætat. 25, of apparently strong constitution, Feb. 24, 1874. At Christmas time (1873) she had—so far as could be inferred from her own account—an acute attack of inflammation of the middle ear, associated

with a purulent discharge from the external auditory canal. Three weeks ago the ear became painful again, and leeches were applied near the orifice to relieve the pain. In the course of a few days the orifice seemed to become entirely closed by the swelling of the parts. The pain increased and she became quite drowsy. Dr. E. B. Bronson, who was called in to see her at the time, divided the mastoid integuments very freely with the knife. This afforded the patient great relief from her suffering, and all symptoms of drowsiness soon disappeared. Two days later (Feb. 24) I made an examination of the ear, and found the meatus closed by a number of small wart-like growths, situated on opposite sides of the canal. These growths are very firm in texture, being covered apparently by true skin. The largest is as large as a pea, and springs from the base of the tragus by a broad base. A thin watery pus bathes these masses, and their presence renders it impossible for one to see the deeper portions of the canal or the drum membrane. By aid of the probe, however, I was able to ascertain that these growths were not connected with any sinus or region of exposed bone. As the patient was under treatment at the time for a large ulcer of the vulva, it was believed that these growths were of syphilitic origin. (Patient was not seen again.)

In very many cases of deafness dependent upon syphilis, it is impossible to ascertain whether the loss of hearing is due wholly to changes that have taken place in the conducting apparatus of the middle ear, or to these in part and also to an implication of the auditory nerve. The most we can do, by way of classification, is to place in one class those cases in which the pathological condition of the middle ear (including the membrana tympani) appears to be sufficiently marked to account for the whole of the loss of hearing; in a second, those cases in which the nearly or fully normal condition—so far, at least, as we can ascertain by inspection and by auscultation during the act of inflation—of the middle ear contrasts strongly with the diminution in, or total loss of, the power of hearing; and finally, in a third, those cases in which the middle ear presents unmistakable evidences of pathological changes, but yet not sufficient to explain wholly the marked diminution in the hearing. The first class would comprise cases of what might fairly be designated "syphilitic disease of the middle ear;" the second, cases of "syphilitic disease of the auditory nerve";[1] the third, cases of

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[1] **The labyrinth is usually assumed to be the seat of the disease, and in most cases probably correctly. (This point will be considered briefly farther on.)**

"syphilitic disease of the middle ear and auditory nerve." It must be borne in mind, however, that a case which at first belongs very properly in the first class, may very soon pass into the second or third. The adoption of such a subdivision of the cases into three classes is therefore purely a matter of convenience and orderly arrangement, a scientific subdivision based upon pathological anatomy being hardly possible in the present state of aural pathology.

Seven of the thirty cases belong in the first of these three classes. While only one or two of them are of special interest, the others are also given in as brief a manner as possible, for the reason that it seems to me desirable to furnish as complete a picture as I can of the *whole* material observed. The rarity or frequency of the different lesions will thus be better appreciated.

Case VI.—Male, ætat. 24, Dec. 15, 1875. Difficulty of hearing, referable chiefly to the left ear. Duration, eight weeks. Manubrial and peripheral vessels of the drum membrane congested; elsewhere the membrane is opaque, of a milky hue, and slightly œdematous. Left tonsil very much enlarged and of a bright red color; crypts filled with a dirty-looking secretion (ulcerated ?). Patient gives a history of syphilitic poisoning. (No further data).

Case VII.—Male, ætat. 35, in fair health, Aug, 25, 1875. Discharge from right ear of recent origin. No history of an acute beginning. Membrana tympani covered with thick pus, red, swollen, and united with the mucous membrane of the promontory; syphilis contracted eight months previously.

Treatment.—Iodide of potassium to be taken internally, and a weak solution of acetate of lead to be instilled into the external auditory canal. Patient never returned.

Case VIII.—Male, ætat. 23, laborer, Dec. 8, 1875. Pain in the left ear during the past twenty-four hours. Membrana tympani thickened and of a pinkish hue. The upper portion of the inner end of the external auditory canal and the soft parts forming the upper boundary of the drum membrane are uniformly red, and so much swollen as to present almost the appearance of a forming abscess. Syphilitic ulceration of velum palati. Treatment was begun, but the patient did not return a second time.

Case IX.—Male, æt. 25, in poor general condition, Nov. 26, 1873. About one week ago he experienced pain in the left ear, followed soon by deafness, ringing in the ear, and a discharge of bloody serum. All of these symptoms still persist; the discharge from the ear, however, being now purulent in character instead of serous. Examination with the speculum and reflected light shows the membrane to be red, swollen, perforated anteriorly, and covered with pus. Tenderness on pressure over the mastoid process. The patient hears the ticking of a watch only when it is pressed against the auricle. Extensive syphilitic ulceration of the soft palate. Chancre three years ago, followed by exanthem, pharyngitis, etc.

Treatment.—Free incision through the membrana tympani, as the existing perforation does not seem to afford a sufficiently free escape for the pus formed in the middle ear; three leeches to be applied behind the ear; syringing with warm water.

Dec. 1. Patient had only one leech applied, instead of three. Pain still persists. Mastoid integuments are now red and swollen. Three leeches ordered.

Dec. 3. The patient was greatly relieved for several hours by the local depletion. The pain then returned and is now quite severe again. Free incision through the mastoid integuments. Poultices to be applied at short intervals.

Dec. 10. Patient is slowly improving. Otorrhœa has ceased. Only occasional twinges of pain.

Dec. 17.—Entire freedom from pain. External wound has nearly healed. (No further data.)

CASE X.—Male, ætat. 37, in a somewhat cachectic condition, June 11, 1874. Last November he had a double otitis media purulenta in connection with a bad syphilitic sore throat. Hearing power has rapidly diminished since then, and he is now so deaf that I am obliged to speak to him in a very loud tone of voice. Constant tinnitus. Right membrana tympani and adjacent walls of meatus red and swollen. Left membrana tympani perforated; in other respects it is in the same condition as the right. Soft palate has formed adhesions with the posterior wall of the pharynx, and is otherwise disfigured by syphilitic ulceration. (No subsequent data.)

CASE XI.—Male, æt. 24, well-nourished. Oct. 9, 1878. Double otorrhœa of several weeks' standing. No history of anything like an acute beginning, nor does he remember to have had otorrhœa before the present attack. Syphilitic ulceration of velum; diffuse redness and swelling of entire fauces. Right external auditory canal filled with pus. The membrana tympani, after the removal of the pus, was found to be of a bright red color, very much swollen, and perforated in two spots—below and in front, and posteriorly near the umbo. A whitish material filled the posterior perforation. In a word, the drum membrane presented precisely the same appearance (color, condition of ulceration, diffuse swelling) as did the soft palate. No note was made of the condition of the left ear. (Only one subsequent visit.)

CASE XII.—Male, ætat. 37, a gardener, in good physical condition, Sept. 25, 1872. Seven years ago he first noticed that his hearing was growing less sharp than usual. Constant tinnitus aurium. Slow increase of deafness. At the present time I am obliged to raise my voice a little, in order to make myself heard by the patient. The ticking of my watch is heard by him at a distance of three inches on the right side, while on the left side he can only hear it when the watch is pressed against the ear. Pharyngeal mucous membrane pale and "sclerosed." Both drum membranes opaque and somewhat whitish in color, but perfectly normal in position.

Treatment (twice a week).—Inflations, according to Politzer's method; mopping out the naso-pharyngeal space with a twenty-grain solution of nitrate of silver.

Oct. 9. Pharyngeal mucous membrane is now red and somewhat swollen.

Nov. 20. Ten days ago, according to his account, he began to suffer from pain in the left ear. Three days ago a serous discharge made its appearance, and has continued since. On examination, the left drum membrane is found to be red and swollen, with a small perforation in the anterior inferior quadrant. The handle and short process of the hammer are no longer distinguishable. No bulging of any part of the membrane.

Nov. 26. Perforation has apparently healed. Otorrhœa has ceased. During inflation the air is heard through the auscultation tube to enter the middle ear in a continuous current, without râles. The drum membrane is still red, swollen, and parchment-like on its outer surface.

Dec. 4. To-day the right drum membrane is found to be red and swollen. No history of pain in the ear.

Dec. 7. Redness of right drum membrane less marked.

Dec. 14. Condition of the left drum membrane has again changed. It is now of a bright red color, moist, more decidedly swollen than at the last visit, and covered in front with a thick white mass, suggestive of a growth of vegetable fungus. Examined under the microscope, however, this mass was found to be composed entirely of large flattened epithelial cells. Perforation again visible in the anterior inferior quadrant.

Dec. 18. Swelling of left drum membrane has again diminished. Perforation is barely recognizable as a black point.

Jan. 15, 1873. Pharyngeal mucous membrane is still red and swollen. Patient complains of constant pain in the ears. He can no longer distinguish the ticking of a watch in either ear. A perforation has also formed in the right drum membrane. A well-defined circular white spot has developed, since the last visit, in the posterior superior quadrant of the left drum membrane.

Jan. 29. Pain continues. A second perforation now exists in the left drum membrane; it is located at the site of the circular white spot noticed at the last visit.

March 5. Patient has not visited the Infirmary since the last date. His general condition has very much changed during the interval. He is emaciated. His face wears constantly an expression of pain. Pulse rapid and feeble. He states that he has suffered a great deal since his last visit with pain throughout the left side of the head. Discharge from the left ear copious and fetid. Total loss of hearing in the left ear. The tones of a vibrating tuning-fork are referred to the right ear, even when it is placed upon the left temporal bone. At the innermost portion of the left meatus the upper cutaneous wall of the canal appears to be in a collapsed condition. By means of a probe this collapsed portion can be lifted back nearly to its natural position, though not sufficiently at all points to bring the membrana tympani into view. When passed farther in, the probe encounters quite an extensive region of denuded bone. No special change has taken place in the right ear, except that the hearing is so poor that we are obliged to communicate with him by writing.

June 25.—Patient is barely able to walk about without assistance, owing to his feeble condition. Left side of face paralyzed. Tongue swollen and ulcerated. He admits to-day, for the first time, that ten years ago he had a chancre, followed soon by sore throat and other characteristic symptoms. He has been an inmate of one of the large general hospitals of the city for several weeks past, and declines to enter the Infirmary. (This was his last visit to the institution.)

The third class includes a larger number of cases than either of the two others, viz., eleven. Each of these, however, is so nearly a repetition of the others, that I shall introduce very brief sketches of only two.

Case XIII.—Male, ætat. 24, Jan. 3, 1874. Steadily increasing deafness during the past few weeks. "Cold in the head" during the past two months. Both drum membranes dull and opaque, but occupying a natural position and free from evidences of active inflammatory action. Mucous patch on one tonsil. Chancre in September, 1873. (Patient did not return.)

Case XIV.—Male, ætat. 35, in excellent general condition, Sept. 13, 1874. Quite rapid and decided diminution in the hearing power of the right ear. Syphilis of recent date. Pharyngeal mucous membrane red and swollen. Right membrana tympani dull, milky, and a little sunken. (Patient returned only once.)

To the *second class*, finally, belong the following seven cases, in all of which it is fair to assume—from the comparatively normal condition of the middle ear and from the history of the case—that the labyrinth or its immediate vicinity was the seat of the pathological changes that caused the deafness.

Case XV.—Male, ætat. 31, of fair constitution, April 17, 1874. Hearing in right ear poor for many years past. Contracted syphilis eighteen months ago. About ten months ago he began to lose the hearing of the left ear. At the present time he is very deaf. On examination, I find the left drum membrane to be nearly normal in appearance. (Patient returned only once.)

CASE XVI.—Male, ætat. 29, in good general condition, March 24, 1877. (Consultation with Dr. D. B. St. John Roosa.) Sudden and almost complete loss of hearing about two months ago. Chancre eighteen months previously. No other evidence of syphilis, with the exception of an ill-defined ulcer on the right side of the tongue, near its tip. Nothing worthy of note in the condition of the middle ears. Antisyphilitic treatment (by Dr. Roosa), consisting of inunctions with the oleate of mercury and the internal administration of iodide of potassium in large doses (reaching 6 drachms in a single day on one occasion), brought about, in the course of a few weeks, a very marked improvement of the hearing.[1] (Full details with regard to this case will be found on p. 528 of the fourth edition of Dr. Roosa's *Treatise on the Ear.*)

CASE XVII.—Female, ætat. 40, a teacher, somewhat anæmic, Oct. 6, 1877. Totally deaf in the right ear since childhood. Two weeks ago she began to notice slight deafness in the left ear, together with occasional pains and a sense of tightness in the ear. Left drum membrane apparently normal. The ticking of a watch heard at a distance of four feet. Right drum membrane very much disfigured by inflammation that occurred during childhood. Pharynx healthy. As there are no indications for treatment, she is advised to wait.

On the 23d of October she returned. The hearing power had been steadily and even quite rapidly diminishing. Tinnitus constant. On the 12th she began to experience a sensation of dizziness, which soon became so marked that she could only walk with the assistance of a friend. No change in the condition of the drum membrane. Treatment: iodide of potassium in fifteen-grain doses three times a day.

Oct. 30. Slight improvement in the hearing; dizziness the same. Dose of iodide of potassium increased to twenty grains three times a day.

Nov. 28. Hearing is now, so far as she herself can perceive, as acute as when I first saw her on the 6th of October. The ticking of the watch is heard at a distance of four feet. The dizziness has also disappeared entirely, though a little tinnitus still remains. All treatment is to be stopped.

From her physician, Dr. Charles Packard, I learn that he has had occasion to treat her for a suspicious periostitis on both tibiæ. The deafness was therefore probably due to a syphilitic affection of the labyrinth or its immediate neighborhood.

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[1] It should be stated here that this patient had already been subjected to what might be termed an ordinary course of antisyphilitic treatment. Little or no benefit, however, resulted. It was not until the more vigorous antisyphilitic plan of treatment was instituted—the plan which Dr. Roosa was the first, I believe, to employ in these cases of sudden and complete deafness—that decided benefit was obtained.

Case XVIII.—Male, ætat. 21, somewhat anæmic, Oct. 5, 1878. (Consultation with Dr. Samuel Sexton.) Thirteen months ago he suddenly lost his hearing in the left ear. Twelve weeks ago he lost the hearing power of the right ear, and is now totally deaf, at least so far as hearing spoken words is concerned. He denies ever having had a chancre or eruption of any kind. He admits that he has had "sore throat" at different times during the past two years, and also occasional severe headaches. About one year ago he had an iritis, for which iridectomy was performed by a London surgeon. Slight enlargement of the occipital glands. Both drum membranes are opaque and apparently thickened. No evidence of active irritation, of the presence of fluid in the middle ears, or of closure of the Eustachian tubes.

Nov. 5. Dr. Sexton informs me that since the last note the patient has been taking regularly the iodide of potassium and red iodide of mercury internally, and the mercurial ointment by inunction, and that he is now decidedly under the influence of mercury. Little or no improvement, however, has taken place in the hearing. (Patient returned to his home in Massachusetts.)

Case XIX.—Male, ætat. 35, of vigorous constitution, Feb. 3, 1871. Chancre ten years ago, followed by secondary symptoms. About the same time he had a discharge from the left ear, which gradually passed away, leaving him totally deaf in that ear. Of late he has begun to be troubled with tinnitus and deafness of the right ear. Gait is noticeably staggering. Examination shows the left drum membrane to be cicatricial throughout the posterior half. The right membrane is somewhat sunken. A peculiar wine-colored circular discoloration occupies the posterior inferior quadrant of the membrane. Soft palate and nose show evidences of former syphilitic disease. The tones of the vibrating tuning-fork are promptly referred to the right ear, no matter at what portion of the skull the fork is placed. Treatment was directed to his naso-pharyngeal catarrh, which was then quite active, but it failed to produce any improvement in the hearing.

On January 20, 1872, he again consulted me. The right ear was then already totally deaf. Staggering gait still present. (No further data.)

Case XX.—Male, ætat. 14, poorly nourished and very anæmic. He is apparently totally deaf. The mother states that he has never had either earache or discharge from the ears, but that when seven years old he manifested symptoms of disease of the nose and soon afterward almost completely lost the power of hearing.

On examination, both drum membranes are found to be much thickened and unusually whitish in color, except at the periphery and along the handle of the hammer, where the tissues present a bright red appearance. Velum palati red, swollen, and deeply ulcerated on the right side. Depressed cicatrices in each submaxillary region. Bridge of nose appreciably enlarged, through disease of the nasal bones or cartilages. The boy breathes entirely through the mouth. (Hereditary syphilis ?)

On Oct. 9th he began taking the bichloride of mercury, in doses of one-thirty-second of a grain three times a day, in combination with iodide of potassium, ten grains to the dose.

On the 23d, inunctions with the mercurial ointment were prescribed in addition to the internal treatment.

Oct. 30th. All redness of the membrana tympani and external auditory canal has disappeared. The velum, too, has lost all evidences of inflammatory action, and, apart from the defect, presents a perfectly natural appearance. The boy seems brighter and less anæmic, though still perfectly deaf.

Nov. 13. General condition steadily improving. (Case still under observation).

Case XXI.—Male, ætat. 45, in fair general health, March 22, 1876. Eighteen months ago he became paralyzed on the left side of the body, and also noticed that his hearing in the left ear was not as acute as usual. Already six months prior to this he had noticed that he sometimes saw double. Five months ago he quite suddenly—in the course of a few minutes, he says—lost the hearing in his right ear. This was associated with more or less dizziness, which has steadily increased from that time to this. He admits having had syphilis at the age of thirty-five. On examination, both drum membranes are found to be in a nearly normal condition.

He was given iodide of potassium in slowly increasing doses, but he ceased to visit the Infirmary before any appreciable improvement had yet taken place, or could reasonably have been looked for.

The question which suggests itself in this connection, and which almost every writer on otology has raised, is this: Are the pathological changes which syphilis produces in the ear sufficiently distinctive of the disease for us to recognize them at once as syphilitic, without the aid of collateral evidence? Schwartze, who has carefully looked into all the works that had been written on the subject prior to 1869,[1] and who gives a summary of his own observations, cautiously avoids answering the question directly. He describes five classes of cases which have come under his own observation, and in which he believes that the functional or organic changes were due to constitutional syphilis. In the first class he includes cases of syphilitic ulceration of the meatus. The peculiarity of the ulcer, in these cases, lay in its annular shape (surrounding the orifice) and in its being covered with a dirty white secretion. He adds that in the external auditory canal polypoid granulations undoubtedly occur, which must be considered as a local manifestation of constitutional syphilis. "As granulations of this character, however, are exceedingly common in non-syphilitic individuals affected with a purulent inflammation of the ear, it becomes a very difficult matter to decide in a given case whether the growths are or are not of a specific nature. From the anatomical examination alone, no definite conclusion can be drawn. The characteristic papillary structure of the tumor, which sometimes presents the appearance of a perfectly developed condyloma, is also observed in cases where syphilis is not to be thought of for an instant." Roosa[1] states that syphilitic affections of the auditory canal are extremely rare, he himself not having seen "affections of the auditory canal which could be said to be the result of the poison of syphilis." Burnett[2] also seems to have had the same experience. On the other hand, August Stoehr has published an article[3] on the subject of "broad condylomata in the external auditory canal," from which it appears that he has seen no less than fourteen such cases. Gruber, also, describes[4] broad condylomata in the external auditory canal.

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[1] Archiv für Ohrenheilkunde. Vierter Band. Würzburg, 1869, p. 253 et seq.

In both the cases (IV. and V.) that I had an opportunity of observing, the picture presented to the eye, when the external auditory canal was first examined, was so characteristic and striking that I at once recognized it as of syphilitic nature. In no other form of ear disease have I ever seen the external auditory canal studded with broad-based and rather tough growths, interspersed with smaller, more pointed, and more delicate ones. In Case III. the picture presented was much less striking; and yet even here the observer, if familiar with diseases of the ear, could hardly fail to be struck with the contradictory state of things. In children, for example, the external auditory canal is very apt to become ulcerated by the constant flow of an irritating secretion over its inner surface; but in adults this rarely happens, and then almost always in connection with a chronic discharge from the ear. Ulcers in the form of fissures or cracks at the very orifice of the canal (eczema) are occasionally met with in adults who are entirely free from any syphilitic taint.[1] I have also sometimes seen a small circumscribed ulcer (or patch of granulation tissue) corresponding to the imperfectly healed orifice of an abscess located in the walls of the external auditory canal. Finally, I have seen a similar condition of ulceration (or condition of granulation) in the osseous portion of the canal, close to the membrana tympani, as a result of the pressure caused by a calcareous mass. In all of these cases however, an adequate local cause was obvious, without recourse to the assumption of a syphilitic origin. In Case III. a comparatively large and well-defined patch of granulation tissue had developed in a canal which presented almost no other evidence of inflammation, and which had been subjected to no other irritating influence than the flow, for the period of a week, of a purulent fluid over its surface. Unlike the condylomata, the ulcer, in and of itself, presented nothing typical or distinctive of its syphilitic nature. It was the presence of this well-defined lesion without evidence (either in the surroundings or in the history of the case) of an adequate cause, which led me to suspect the existence of constitutional syphilis.

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[1] Treatise on Diseases of the Ear, Second Edition, p. 144.

[2] A Practical Treatise on the Ear. Philadelphia, 1877.

[3] Archiv für Ohrenheilkunde, 1869. Fünfter Band, p. 130 et seq.

[4] Ueber Syphilis des Gehörorgans, Wiener Med. Presse, 1870. Nos 1, 3, and 6.

Writers on diseases of the ear are, I believe, nearly unanimous in the statement that lesions characteristic of syphilis are never observed in the middle ear or membrana tympani. While I do not feel justified as yet in disputing this statement with any great degree of positiveness, owing to the scantiness of the material which has come under my observation, I cannot help feeling that, with increased experience and a closer study of this particular class of cases, we shall in time learn to recognize in these parts textural lesions as distinctively characteristic of syphilis as are most of its external manifestations. Take for an example Case XII. The development of a second perforation in the left membrana tympani, through a melting process similar to that observed so frequently in the velum palati, is totally different from anything that I have ever observed in any case of non-syphilitic inflammation of the middle ear. In Case XI. probably this same melting away of a limited area of the drum membrane took place, though in that case I only had an opportunity of observing the process at its stage of completion. There were no evidences of pressure from within in either of these cases; in both, the loss of substance could only be described as a melting away or death of the tissues. In Case XII. furthermore, the subsequent course of the disease—the development of caries and facial paralysis, with no evidences of interference with the free escape of the pus formed—was certainly not in harmony with the ordinary course of a non-syphilitic otitis media purulenta acuta.

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[1] Dr. Ladreit de Lacharrière, in the "Annales des Mal. de l'Oreille et du Larynx" for May, 1875 (vide Burnett, Treatise on the Ear, p. 271), describes a form of acute syphilitic otitis which is characterized by a fissured and cracked condition of the skin of the external auditory canal, and by a copious and very disagreeable discharge. Such a condition as this, however, is totally different from the fissured ulcers observed in eczema. No other authority, as far as I know, has described anything similar to the condition observed by de Lacharrière.

With regard to the cases in which the auditory nerve, either before or after its entrance into the labyrinth, is the part believed to be principally affected by the constitutional disease, I find again that my material is far too scanty and too imperfect to justify any special conclusions. In these cases it is generally assumed that the labyrinth is the seat of the syphilitic lesion. It is quite possible, however, that the lesion may be in the middle ear, or in the auditory nerve before it enters the labyrinth. It is a peculiarity of poisoning by syphilis that almost any spot in the body may become the seat of well-marked textural changes, such as increased vascularity, infiltration, proliferation, or death. The parts in the immediate neighborhood may exhibit no evidences whatever of participation in the process. Thus, for example, the mucous membrane lining the niche for the round window, or the membrana tympani secundaria itself, may become congested and very much swollen, without narrowing of the Eustachian tube, without the exudation of fluid into the middle ear, and without the slightest change in the condition of the drum membrane — or, in other words, without any discoverable evidence of disease in the middle ear. The swelling of these parts, and especially of the secondary tympanic membrane, cannot take place without producing pressure upon the fluid of the labyrinth (semicircular canals as well as cochlea). This lesion, therefore, would be competent to produce the hardness of hearing, the staggering gait, and the dizziness observed in Case XVII., for example. If not arrested by treatment, the swelling might increase to such a degree that the displacement outward of the foot-plate of the stirrup would no longer compensate for the pressure exerted at the round window upon the contents of the labyrinth. In that event we should have not only a mechanical interference with the working of the cochlear apparatus, but also an intralabyrinthine anæmia (due to pressure) which would very soon cause disturbances in the nutrition of the delicate structures of the cochlea. All degrees of hardness of hearing might in this way be produced.

Lesions at the oval window, by obstructing the action of the stirrup, would likewise be competent to diminish very materially the power of hearing. Thus, even complete anchylosis of the stapedio-vestibular articulation might result from syphilitic disease.

Finally, still another possibility must be taken into consideration. The auditory nerve, after its separation from the facial in the meatus auditorius internus, passes through the minute openings in the cul-de-sac of the meatus and enters into numerous bony channels in the modiolus. The most insignificant pathological changes in these minute channels—changes which it might be difficult to detect even with the microscope—would suffice to inhibit the functional capacity of the bundles of auditory nerve filaments contained within them.

In the present state of our knowledge of aural pathology, therefore, we are hardly justified in using the expression "labyrinthine disease," except in those cases where demonstrable lesions are found in this part of the ear at the post-mortem examination. At the same time it is difficult to suggest a better term, even for temporary purposes.

THE USE OF CALCIUM SULPHIDE IN THE TREATMENT OF INFLAMMATIONS OF THE EXTERNAL AUDITORY MEATUS.

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NEW YORK.

The persistency and painfulness of certain well-known inflammatory processes of the external auditory meatus, and the futility of the remedies which have hitherto been available in their routine medication — surgical means excepted — have spurred the writer to numerous experiments with the hope of ascertaining the action of any that would relieve the distressing symptoms. None, however, were attended with the success hoped for, and patients were left to time-honored measures until an experiment with the sulphides was decided upon. This selection was made chiefly because they were reputed to control the suppurative processes, under certain circumstances, in other parts of the body. The sulphide of calcium was selected for trial, and the conditions of the ear in which it was used were the following, namely, furuncles and diffuse inflammation. Its use was extended to certain cases where the inflammatory action tended toward suppuration: in erythema, eczema, pemphigus, herpes, erysipelas, etc.

Furunculous inflammation, which is described by Schwartze as a perifollicular inflammation in the skin, is especially liable to affect the outer extremity of the external auditory meatus, and frequently, owing to the richness of the locality in connective tissue, the inflammation extends deeply and becomes phlegmonous in character. Diffuse inflammation in the skin of the meatus, although liable to result in abscesses, etc., at the outer third of the canal, is most frequently found in the deeper portions, where, owing to the absence of connective tissue, its behavior is different, and there is likely to be periostitis as well as an extension of the inflammation to the drum-head. These affections are characterized, as is well known, by their tedious nature, their remote causes being usually of long continuance. One crop of furuncles after another appears indefinitely, unless arrested by treatment; and the diffuse inflammation, it may be stated, acts in a similar manner. The irregular recurrence of these affections, where the causes remain, is to be looked for, in some patients, for years, the attacks being mostly in warm weather, but not always.

It is not my purpose here to enter into details as regards the etiology, pathology, and general symptoms of these affections, as it would lead me far away from the purpose of the present paper.

As regards the usual treatment of these affections by incisions, together with the application of leeches, it may be said that although these are frequently indicated, there are a large number of cases where the conditions—idiosyncrasy, etc.—seem to contraindicate their use, the patients being made much worse by the procedure. It is in such cases, which every aurist frequently meets with, that the remedy here proposed seems to act with especial advantage. There are also cases where the suppurative action is uncommonly slow, in which the remedy seems to act favorably.

That sulphur and its compounds have long possessed great repute as curative agents, both in the profession and among the laity, is a fact well known. Its uses have extended to an important list of affections, and there can be no doubt but that it is justly entitled to the high estimate that has so long been placed upon its merits.

The sulphureous waters of the earth, appearing in springs upon its surface, have for a long period of time been sought for on account of their reputed healing virtues.

Sidney Ringer[1] says of the sulphides: "The sulphides appear to me to possess the property of preventing and arresting suppuration. Thus, in the inflammation threatening to end in suppuration, they reduce the inflammation and avert the formation of pus. The influence of this group on the suppurative process is still more conspicuous after the formation of pus. They then hasten maturation considerably, whilst at the same time they diminish and circumscribe the inflammation, promote the passage of the pus to the surface and the evacuation of the abscess." Ringer, in speaking of these remedies as producing different and apparently opposite effects, as the dispersion of inflammation in one case and the expulsion of pus in another, likens them to poultices and hot fomentations, which both subdue inflammation and prevent suppuration, and in other cases considerably hasten the process. The therapeutic action of this remedy is not well understood, but a careful reading of Ringer's work will throw some light on the subject. My own experience in the use of this remedy for aural affections began more than two years ago, and it extends over a very considerable field of private and dispensary practice. I feel justified from the experience thus had, in this special department, in confirming what has been here quoted from the writings of Ringer, the results obtained having been in many instances quite a surprise to me.

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[1] A Hand-book of Therapeutics, Fifth Edition, Wm. Wood & Co., New York, 1876.

I have been in the habit of administering the calcium sulphide in nearly all cases where inflammation of the meatus externus was a symptom, in some stage or other of the disease, but especially in those where suppuration has occurred or threatens to occur. Should there be caries of the bone, periostitis or extensive destruction of the tissue in connection with these affections, the remedy may also be employed. In scrofulous affections this medicine is much praised, and in certain cases it is said to improve the general health.

Furuncles in the meatus, under the use of this medicine, are frequently observed to abort and dry up without a discharge of pus. In some instances I rely entirely on this medicine in the treatment of inflammation in the ear; but free incisions are in some instances, of course, not to be omitted, as when the pain is urgent from distention, or a collection of pus exists which is too large to be absorbed. Leeches should be resorted to when arterial tension is great and the parts are highly engorged with blood; but in cases where they seem to provoke irritation, they should be repeated with much caution. The prevention of a continuance or a return of furuncles, etc., by this remedy, is very clearly possible, provided no remote cause be left active.

The preparation of calcium sulphide that I have lately used is the first decimal trituration,[1] of which I direct about a grain to be taken every two or three hours in urgent cases; in subacute cases with less frequency. In children the dose should be less, a grain of the trituration being diffused in water; the amount to be given can be easily graduated.

The medicine is usually given dry upon the tongue, and the only unpleasant symptoms complained of by the patient are the bad taste, and in rare instances slight nausea.

The decided effect of this medicine may often be observed in the drying up of the sores in the meatus in twenty-four hours; but I am in the habit of continuing it for some days, then discontinuing it unless the symptoms seem to again indicate its use.

This preparation can be obtained from Caswell, Hazard & Co. New York, under the name of Hepar Sulph. Calc. 1^x Trit.

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[1] See Piffard, "On the Use of certain Triturations," Medical Record, Dec., 1877.

BOOK NOTICES.

The Pathological Anatomy of the Ear. By Herman Schwartze, M.D., Professor in the University of Halle. With the Author's Revisions and Additions, and with the original illustrations. Translated by J. Orne Green, A.M., M.D. Houghton, Osgood & Co., Boston.

In no branch of medicine has there been a greater need for special pathological work than in the department of otology, for the subject had been left by Toynbee, the great English pathologist, in its infancy nearly twenty years ago. Since that time no one has essayed to produce a systematic treatise on this subject, although the current medical literature during the existence of this hiatus has not been devoid of interest to the aural pathologist.

Up to this time, however, the growth of the subject has, as it would seem, been necessarily slow, and the progress which has been maintained by the untiring efforts of a very few individuals was gained by labor performed under great disadvantages. This has been owing, in part, to the difficulties which naturally lie in the way of thoroughly inspecting some portions of the ear during life, of pursuing post-mortem investigations, and perhaps, also, to the fact that scientific research has, for some reason, found more inviting and more lucrative fields elsewhere in the domain of medicine.

The ground, however, having been cleared by the faithful work of Toynbee, others have found their work much lightened.

Of late years, foremost among those who have been most actively engaged in aural pathology are the Germans, and, as would be expected, from the contributions of his countrymen the literature of Professor Schwartze's work is chiefly drawn. He has, however, not neglected to collect his literature from the most remote authorities down to the present day, and his formidable list begins with Duverney, whose work was published in Paris, 1683; and it includes Bauhinus (Basel), 1687, Valsalva (Bonn), 1704, Rivinus (Leipsic), 1717, and a great many others equally well known in connection with the subject.

The author acknowledges, in referring to later writers, and the remark may well include those just mentioned, that they have mostly done but little work which is of any value to the pathologist. He says in the introduction: "The pathological histology of the labyrinth of the ear is still in the first stages of its development, and needs the services of an extraordinary anatomist, who must work deeply and thoroughly in this most difficult field for years to bring forth any results. What has been done by some in this field, of late years, with the most earnest endeavors, is scarcely more than a sad dilettanteism, and has no special value for science."

As regards the general character and scope of this work, and the peculiar fitness of the author for the undertaking, we can do no better than quote from the translator's preface.

"It is the only comprehensive work strictly devoted to the pathological anatomy of this organ, and on account of the opportunities and devotion of the author in this special field, his well-known thoroughness and strict impartiality in scientific researches, it is a most valuable addition to the literature of otology. It is essentially a hand-book on the subject of which it treats, a small amount of space often sufficing to give the results of researches the laboriousness of which can only be appreciated by those who have been engaged in similar work."

After carefully reading this work we are enabled to fully endorse the translator's eulogium, and in entering upon a review of its pages feel that it is a difficult task to do the author justice in the space allotted for the purpose.

Schwartze's hand-book at the outset introduces the necessary directions for dissecting the ear. To those who have had this work to do, it will be unnecessary to point out their value, but whoever shall extend his researches in this direction will find them to be of great value, be he specialist or general surgeon.

These directions are most complete, and they also include the method of Professor Lucae.

Schwartze's experience is that a truly normal ear is seldom found in dissection.

The abnormal conditions found in the middle ear may be brought on by the agony or be post-mortem in character, but there are found, besides these, regular changes which pertain to those who have died of heart and lung diseases, and are the result of venous congestion in the branches of the vena cava superior. The most frequent diseases affecting the ear are the acute exanthemata, typhus, acute and chronic catarrh of the nose and naso-pharynx, with their results, tuberculosis, diseases of the heart, syphilis, puerperal fever, and chronic alcoholismus. Passing on from the introduction, the temporal bone in general is the first subdivision of the subject which engages attention. The author begins by describing the malformations. Among other results of researches here, he finds that in hydrocephalus the temporal bone is much altered, being in fact turned downward and arched. Ossification defects are common; an interesting one is styled pneumaticity of the pars petrosa, and consists in the existence of anomalous air-cavities in the bone, which in some instances are filled with a gelatinous red tissue. They are situated on all sides of the labyrinth, and even extend to the upper wall of the meatus auditorius, connecting with the mastoid cells. Hyperæmia, atrophy, osteoporosis and hyperostosis of the bone, are described. Caries and necrosis of the temporal bone have a particular interest for both the otologist and general surgeon, as they are conditions frequently met with in practice, and Professor Schwartze's account of these conditions is most complete.

This entire section is of great interest, and although we cannot dwell as fully as we should like, for each paragraph is replete with instructive knowledge, we may be permitted to state one important fact drawn from this portion of the treatise, namely: that brain abscess is a lesion depending primarily upon caries of the ear in the greater number of instances. Formerly it was believed that the brain abscess was the forerunner of caries and sought an outlet for itself through the cavum tympani. Morgagni first asserted this fact confidently, and it is now generally accepted, although the possibility of an abscess in the cerebrum or cerebellum discharging itself through the temporal bone is not denied; indeed, abscesses of the brain are well known to seek an outlet through the ethmoid, frontal, sphenoid, and parietal fissures, as being the natural outlet under some circumstances.

Referring to the bone in general, it is stated that fractures of the base of the skull are usually attended by rupture of the membrana tympani and bleeding from the ear, but not always. Death from inflammation of the brain and its membranes usually results from fractures of the petrous bone, although they may not develop for several weeks after the injury. Professor Schwartze here remarks that "If the reactive inflammation is not fatal, total deafness remains."

Before dismissing the subject of the temporal bone in general, we ought to give the author's description of that somewhat unusual affection, Cholesteatoma, about the pathology of which some authorities are at variance. According to Schwartze, this condition is a true new growth. In the great majority of cases of so-called cholesteatoma, we have simply a retention of the products of inflammatory action in the ear. The source of the large, flat cells found so abundantly in these collections, and which has so often been discussed, is explained by the fact that the tympanic epithelium, under a chronic purulent inflammation with defect of the drum membrane, often assumes the characteristics of the skin, showing a rete Malpighii and epidermis.

Malignant tumors, new growths, and malformations of the external meatus, are of common occurrence. The meatus may be absent, or in its formation it may be defective.

Schwartze regards the congenital abnormal width of the meatus—so large that the little finger may be inserted down to the drum-head—as of little pathological interest. This abnormity has been considered by some as favoring the entrance of cold water in bathing, or draughts of cold air, into the depths of the auditory canal, and thus favoring inflammatory action in the delicate conducting mechanism of the ear. It may be stated on the contrary, however, that the African race, in which a large meatus is the rule, is not especially liable to aural disease of any kind, if their unfrequent attendance at our ear charities may be accepted as an indication.

A description of eczema by the author, under head of anomalies of the meatus externus, will suffice for that affection whenever seated about the ear, and it is a fair example of his concise yet sufficiently descriptive style: "*Eczema* (acute or chronic) is often confined to the external ear. The vesicles may be visible on the meatus and membrana tympani; in most cases, however, only a red and moist skin, from which the epidermis has been separated, is seen. According as pustules or dry scales are formed with the vesicles, the disease is called eczema impetiginosum or squamosum. In obstinate cases chronic eczema of the ear may cause inflammatory hypertrophy of the corium, which can produce stenosis of the meatus, deformity of the auricle, and thickening of the cutis of the drum membrane."

In describing the anomalies of secretion, it is stated that the accumulations may completely fill the meatus, and, extending down to the drum-head, form on the membrane, producing atrophy, or ulceration of the membrane from pressure, or, by forcing the drum-head inward, favor the adhesion to the inner wall of the tympanum. Although it is stated that these results are exceptional, yet we fear the author does not make them exceptional enough, for it is a well-known fact that anomalies of the tympanum and drum-head such as are referred to above, often exist when collections are present in the meatus, being induced by the same cause: as hyperæmia. Differentiation in these cases would usually be difficult. It may be assumed that when secretions are sufficiently unyielding to occasion injury by pressure on the membrane, their presence would not be long tolerated. Indeed, we may well believe that most accumulations of this kind form rapidly, their causes being often of temporary duration. That they often form only as a very narrow diaphragm to the canal is a fact which we have frequently verified, and in such instances the drum-head is of course free. Were most of these accumulations not thus limited, from some unexplained cause, they would increase indefinitely, and, in fact, they could not long be confined within the bounds of the meatus. Exostosis, polypi, parasites, etc., in fact, all the affections of the external meatus receive in their turn the author's attention, but must be passed here.

The drum membrane of course receives a large share of attention, as it is the seat of numerous pathological changes which are of great importance to the performance of the function of audition. The meatus externus and the membrana tympani being situated so as to be easily examined during life, our knowledge of the pathological changes which affect them is far more perfect than it is of the deeper structures of the ear.

Referring to the anomalies of formation, Professor Schwartze expresses a doubt as to whether a double membrane has existed, although described by authors; and he likewise regards the congenital absence of the membrane as an unlikely occurrence.

The author says: "A normal foramen Rivini does not exist."

The anomalies of the drum-head, as regards form, size and inclination, are very frequent. Hyperæmia, hemorrhage, inflammation, etc., are dwelt upon, and there follows an account of the results of inflammation, among which may be mentioned anomalies as to color and transparency.

Opacities and thickenings are included in this part of the section, the former not always corresponding with the latter. Opacities are also found with the atrophied condition.

Perforations and cicatricial formations are not only accurately described, but the subject is further illustrated by the introduction of excellent cuts.

Thirty pages are given up to the pathology of the drum-head. It is not possible, without transferring the text to our pages, to convey to the reader an adequate idea of the completeness of the author's work in this, as in preceding sections.

To the tympanum, which is the next subject in order, thirty-nine pages are devoted. This region is, perhaps, the seat of a greater number of pathological processes than all the other parts of the ear together. In this section, the point of greatest interest is the consideration of the inflammatory affections. Catarrhal inflammation of the tympanum is classified under three heads: (1) serous catarrh, (2) mucous catarrh, (3) purulent catarrh. The inflammatory process is characterized by hyperæmia, swelling, and exudation. Although in most cases the exudation is of a mixed character, still from anatomical investigation it is thought we are justified in distinguishing them as above.

These three forms may occur in the tympanum as clearly defined affections, but the transition forms are much more common. To distinguish them, however, according to their pathological nature, would be inconvenient, and in fact unnecessary, for it would require a large number of subdivisions, as sero-mucous, sero-hemorrhagic, muco-purulent, muco-hemorrhagic, etc.

Schwartze considers the old division into catarrhal and purulent otitis media as undesirable, because the first variety can pass into the second, and there is no definable boundary between them, perforation of the membrana tympani not being an infallible mark of distinction. The description of these forms of inflammation, the chronic varieties of which we have not space to consider, is most clear, and it constitutes a valuable contribution to this subject.

Space will not permit mention of the Eustachian tube, or indeed, of the valuable section on the anomalies of the mastoid process. To describe the thoroughness of one section is to depict the manner of handling by the author in them all, and we can only say that there is no evidence of flagging effort in any part of the work.

From the region of the inner ear it was to be expected that a less complete picture of pathology could be drawn, but nearly all that is at present known on this subject—and the sum of such knowledge is not inconsiderable—may be here found. The conspicuous absence of allusion, in this comprehensive work, to the pathological contributions of our countrymen, cannot well be accounted for. It cannot be owing to the want of a thorough knowledge of our literature, and yet we are loth to accept the other horn of the dilemma and conclude that most of our contributions are valueless.

In casting about for a solution to this fact, we are led to look in on ourselves as it were, and scan the various efforts we have made in this direction. And here an exhibition of our nomenclature presents itself. Should it be taken to represent our present knowledge of aural pathology, would the impression be favorable? For example, we may be detected, in most of our clinical reports, placing all anomalies of secretion of the external auditory meatus under some such designation as "impacted cerumen;" and middle-ear affections are very likely to be grouped mainly under catarrh, either "acute," "chronic," or "acute purulent" and "chronic purulent"; and as for the inner ear, its affections are still more indefinite, owing principally to the fact that a large number of affections are relegated to that region because no convenient place can be found for them elsewhere.

Should this condition of things be taken as indicative of the existing state of knowledge in aural disease, our efforts might well be regarded as unworthy the attention of so careful and conscientious an observer as Professor Schwartze; such a conclusion, however, would do us great injustice, and would, moreover, be a reflection upon the intelligence of the author.

In every portion of this book there is evidence of that thoroughness in research, and patience in the treatment of details which the translator has touched upon in his introduction.

Professor Schwartze's hand-book furnishes us a basis upon which to build a concise and truthful nomenclature of aural diseases, and to him, therefore, every otologist owes a debt of gratitude.

The book contains one hundred and seventy-four pages, and is illustrated by sixty-five woodcuts which are selected in a manner to best explain the text. The impressions of the cuts in the American edition are superior to those of the original German edition, on account of the superior quality of the paper used by the American publishers.

The want of an index does not exist, as the table of contents is sufficient.

Dr. J. Orne Green has, in translating this work, placed the profession under deep obligations to him. Those who best know Dr. Green's own special ability as an aural pathologist can testify to his fitness for the work of this translation. He has adhered to the condensed style of the author throughout, without destroying the sense of the text. No little credit is due him for placing before the English reader a correct rendering of Professor Schwartze's work; and we beg permission here to express the hope that he will be encouraged, by his success in this effort, to place within reach of the profession in this country other works of German origin.

A PRACTICAL TREATISE ON THE DISEASES OF THE EAR, INCLUDING THE ANATOMY OF THE ORGAN. By D. B. ST. JOHN ROOSA, A.M., M.D. Fourth Edition. W. Wood & Co., New York.

THE publication of a fourth edition of this book on the ear may be taken as an evidence that the interest in Otology in this country is on the increase. Dr. Roosa's book has been frequently noticed heretofore by the medical press, and anything we could now add would therefore seem to be unnecessary. Dr. Roosa's work in the meantime has been accepted, both at home and abroad, as a valuable treatise on the ear. Indeed, it is a valuable acquisition to the medcal library of the practising physician as well as that of the aurist. It contains a varied amount of information, which has required patient and intelligent labor in the literature of the subject. Its bibliographical history of the progress of Otology, and its section devoted to the anatomy of the ear, are convenient to have for reference. Dr. Roosa has availed himself of the opportunity offered him by the publisher, in issuing a fourth edition of his book, to revise the chapter on diseases of the internal ear. In perusing this chapter the most noticeable alteration is found to be the introduction of the author's views on syphilitic disease of the ear. The well-known symptom of sudden deafness, usually in both ears, coming on during the progress of secondary syphilis, is considered by Dr. Roosa to arise from an invasion of the cochlea, and he accordingly in his treatment adopts the course advised by syphilographers, in attacking pressing lesions arising during the progress of secondary syphilis with large doses of iodide of potassium. This is doubtless a valuable contribution to the therapeutics of otology, although as yet there has not been sufficient experience in the use of the remedy upon which to base conclusive opinion as to its value. There are those who regard the sudden deafness just referred to as depending on lesions in the middle ear, which in no way involve the cochlea; the opinion, however, can but be held by all, that we are indebted to Doctor Roosa for giving prominence to this treatment of syphilitic aural disease.

LEHRBUCH DER OHRENHEILKUNDE FÜR PRACTISCHE AERZTE UND STUDIRENDE. VON DR. ADAM POLITZER. I. Bd. Stuttgart. Verlag von Ferdinand Enke. 1878.

THE first volume of Prof. Politzer's Treatise on Otology has made its appearance. It is a large octavo of 372 pages, illustrated with 106 woodcuts, and treats of the following subjects: the anatomy and physiology of the auricle, external auditory canal, and middle ear; the various methods and instruments for examining the ear; the different methods of testing the hearing; the diseases of the membrana tympani; acute inflammation of the middle ear; the different varieties of catarrh of the middle ear; and, finally, the diseases of the naso-pharyngeal space in their relations to diseases of the middle ear.

Otologists have become well acquainted with the author of this treatise, through his *Beleuchtungsbilder des Trommelfells,*[1] published in 1865, and also through numerous articles which have appeared in the *Archiv für Ohrenheilkunde* and in other, non-otological, journals. Many of them, too, have enjoyed the privilege of following one of his courses on practical otology in the Allgemeine Krankenhaus at Vienna. In both his writings and his teachings he has been conspicuous for accuracy and clearness of statement, for his thorough knowledge of the anatomy, physiology, and pathology of the ear, and for the conservative character of the remedial measures which he employs and advocates. Those who have admired him for these excellent characteristics will therefore be pleased to learn that in the present volume they will find nothing that might detract from the reputation which he has justly enjoyed. For clearness of style the book has no superior. Those who are familiar with the writings of Virchow will find here the same simplicity and directness of statement which characterize the works of that author.

From beginning to end of the present treatise, the author holds himself strictly to account for every statement which he makes. Wherever he is not satisfied with the proofs furnished by others, he subjects the doubtful point to his own rigid scientific tests, and gives the reader the fullest possible evidence of the truth of his statements. Thus, almost every page bears record to the diligence with which he has, through all these years of a busy practice, prosecuted original researches.

In a text-book destined for students and physicians, one does not expect to find much that is particularly new. Whenever a new fact in any department of otology is discovered, the discoverer is pretty sure to publish it in some journal with as little delay as possible. In a treatise on otology, however, all these discoveries are brought into their proper places, and the book, if successfully constructed by its author, reflects correctly the condition of otological knowledge at the time when the book was written. Judging the present text-book from this standpoint, we may unhesitatingly say that it has attained a high standard of excellence. The beginner in otology will find every point in a theory, as well as every step in a therapeutic procedure, stated with such minuteness of detail, and with such clearness, that he cannot fail to be pleased with the work. The more experienced otologist, on the other hand, will find food for thought on almost every page, and very rarely indeed will he be disposed to quarrel with the author over either his pathological views or the plans of treatment which he recommends.

Our space will not permit us to give a detailed analysis of this first volume of Prof. Politzer's treatise. We have marked a few passages, however, that appeared to us to possess a special interest, and will pass them in review briefly.

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[1] The Membrana Tympani in Health and Disease. With Supplement. Translated by A. Mathewson, M.D., and H. G. Newton, M.D., New York, 1869.

On page 112, the author calls attention to the fact that our estimate of the degree of arching (inward) of the membrana tympani is greatly influenced by the transparency of the membrane. The greater its degree of transparency, the less will it appear to us to be arched; whereas, the more opaque it is, the more marked will the funnel-shaped concavity of the membrane appear to the eye of the observer. Politzer says that if we examine the transparent membrana tympani on a dried specimen of the ear, with the speculum and mirror, in the same manner as we should do it upon a living person, and then repeat the examination after having painted the outer surface of the membrane with a thin layer of white pigment, we shall readily satisfy ourselves of the correctness of his statement. He attaches special importance to this fact because he has had occasion to observe that even specialists, in cases where the drum membrane is slightly opaque, are apt to diagnosticate a sunken condition of the membrane, when in reality its position is a natural one. On the other hand, he states that the position of the handle of the hammer furnishes the best means of determining whether, and to what degree, the membrana tympani is abnormally arched inward.

On page 173, in speaking of his own method of inflating the middle ears, the author states that he is now in the habit of using exclusively an elastic nose-piece (as suggested by Löwenberg) in the place of the curved hard-rubber one originally recommended by him, and still usually sold in the shops. He remarks, however, that a certain degree of practice is necessary in using such a nose-piece, as one is very apt, in closing the nostrils over the soft rubber-tube, to obliterate its calibre entirely. The advantages claimed for this form of nose-piece are, that it is pleasanter for the patient (that is, less painful than where the hard-rubber attachment is used) and less likely to produce nose-bleed. Furthermore, in suspicious cases the patient can, at almost no expense, be provided with his own special nose-piece.

Referring (p. 177) to the statements made by prejudiced persons, to the effect that inflation of the middle ears by his method frequently produces rupture of the membrana tympani, and so may prove an injury to the patient, Politzer replies that "the truth of these statements is disproved by the following facts:

"1st. Ruptures of the drum membrane have been observed not only after the use of his method of inflation, but also after Valsalva's experiment, and even after catheterization of the Eustachian tube; 2d, ruptures of the membrana tympani are of *very rare* occurrence, only fourteen cases having been reported during a period of thirteen years; 3d, the harmlessness of ruptures of the membrana tympani may be inferred from the fact that in almost all of the published cases (Pagenstecher, Schwartze, Lucae, Van Hoeck, and Politzer) a decided and generally permanent improvement in the hearing followed the rupture."

In several places (pp. 181, 294, 319, 340) the author speaks in decided terms against the practice of employing the so-called Valsalva's experiment (inflating the middle ears by forcible expiration with closed mouth and nostrils) as a therapeutic measure. The practice is so widespread, and has the sanction of so many specialists, that it will not appear out of place if we reproduce here in brief what Politzer says on this subject. The Valsalvian method necessarily produces a condition of hyperæmia of the blood-vessels of the head, due to stasis in the veins. Von Troeltsch has called attention to the fact that in persons past middle life, whose cerebral vessels are in a condition of fatty degeneration, Valsalva's experiment may lead to an apoplexy. Politzer bases his objection chiefly upon the fact that the frequent production of a condition of venous hyperæmia in the mucous membrane of the middle ear—such as may be observed after every performance of the Valsalvian experiment—must necessarily induce a permanent state of hyperæmia of the ear, through which not only the existing inflammatory process in the middle ear is increased, but also disturbances of nutrition are produced in the labyrinth. "As the experiment is one which can be performed conveniently at any time, and as the patients at first experience a temporary improvement after each inflation, they are tempted to resort to it frequently—several times a day even, and for months together. In persons addicted to this habit the deafness steadily increases, and may even, as I have observed in a number of cases, reach a high grade."

Under the head of treatment of the different forms of catarrh of the middle ear, the author makes the important statement that, as a rule, it is not necessary to carry on systematic treatment (inflations either by his method or through the Eustachian catheter) for a longer period than from three to five weeks at a time. By the end of this period, as he maintains, either a cure will have been effected, or we shall have attained the maximum of good which it is possible to reach by such a continuous course of treatment. The patient is then to be given a rest of from one to six weeks before the inflations can advantageously be resumed. This, I believe, agrees with the experience of most aurists; yet in many quarters we hear of cases of catarrh of the middle ear where the treatment has been carried on for months at a time.

Those portions of the work which treat of the introduction of fluids into the middle ear where the drum membrane is still intact, of the management of cases of catarrh of the middle ear associated with accumulations of mucus or serum, and of the indications for the use of the myringotome, are those which will probably prove of greatest interest to the practical aurist. It is here that the questions which daily present themselves for solution are discussed in a detailed and careful manner. No arbitrary statements are made, but for every preference or recommendation good and valid reasons are brought forward. To enter more particularly into the details of these sections of the work would almost necessitate a translation.

The volume closes with a thoroughly practical chapter on diseases of the nasal and naso-pharyngeal cavities in their relations to the diseases of the middle ear.

The woodcuts are excellent and seem all to have been made from the author's own drawings, or at all events from his own preparations or cases. The type is large and clear, and the typographical errors are few and unimportant.

In the interest of those who cannot read the book in the original, and indeed, also in the interest of otology in English-speaking countries, let us hope that some competent person will soon furnish a good English version of this manual.

REVIEWS.

ON THE ANATOMY OF THE ORGAN OF HEARING IN RELATION TO THE DISCOVERY OF THE PRINCIPLE OF THE MICROPHONE AND MAGNOPHONE. JOHN DENIS MACDONALD, M.D., F.R.S.: *Nature*, July 11, 1878.—In this paper the writer draws comparison between the principle which governs the action of the microphone, as stated by Prof. D. E. Hughes, and the magnophone of Mr. W. L. Scott, and the function of the otoconia as exhibited in vertebrates.

There are structural particulars, he says, in the ears of vertebrata, which show clearly that nature's philosophy is of a more profound character than that to which man has hitherto attained.

Indeed, if we study the simplest ears in creation, those, for example, of the common snail and periwinkle, a most interesting problem is presented to us to solve, namely, the precise function of the otoconia in one case, and of the single otolith in the other. It is commonly granted that these concretions augment the sonorous undulations by resonance, a view which is borne out by several considerations.

If two stones are struck together under water, the head of the experimenter being also immersed, the collision will produce a loud and peculiar sound; but in order to make the minute otoconia impress each other with the rhythmical flow of the undulations of sound, they must be poised off from the walls of the auditory sac. This is effected, in some instances, by tubercles on the inner surface, as in the cuttlefish or as in the Heteropod, as shown in the auditory organ of Cerophora, in which also large vibratile cilia effect a continual rotatory motion of the spherical otolith.

In other cases, when otoconia are present, a fine ciliated lining not only prevents the contact of these minute particles with the walls of the sac, but keeps them in constant motion, jostling one another in a remarkable manner.

Whatever may be the intrinsic nature of nervous force, it exhibits unmistakable polar properties which would thus place it in the category of the electric force, though no one now would attempt to reason out the identity of the two. It is, however, a new idea that nervous force in the function of audition plays an analogous part to the electric force in the case of the microphone. Moreover, if we look to the anatomy of the ear we see that provision for a complete circuit is made.

As an example of this the author refers to the auditory organ of Cerophora, and infers that nervous force, in traversing the circuit indicated under the influence of sonorous undulations, is actually transmitted from particle to particle of otoconia or through the revolving otolith, as the case may be.

Views similar to those of the author of this paper are also presented by Blyth and F. de Chaumont.

STETHOSCOPIC MICROPHONE. M. DUCRETET.—The interest which has been felt in the medical profession in the possibility of utilizing the microphone as a substitute for the ordinary stethoscope in auscultation, and as a substitute which would permit the use of the sense of hearing in place of the sense of touch in certain surgical manipulations, has been evidenced by the numerous communications on this subject appearing in the columns of the general medical press.

So far the various experiments, not excepting that of Sir H. Thompson with the lithotrite, have been comparative failures; the delicacy of the instrument, and its transmission to the receiving telephone of all sounds consequent upon accidental disturbances of the microphone surfaces, in addition to the movement resulting from the sound which is particularly sought, have resulted in disappointment to many over-sanguine observers.

The latest apparatus, that of M. Ducretet, described in the admirable work of M. le Comte Th. du Moncel on the telephone, the microphone, and the phonograph, while rather more elaborate than any previous form of auscultation microphone, has not overcome this difficulty.

The instrument consists simply of a microphone pencil, supported by a metal arm having a counterbalance at its further end, the point of the pencil resting upon a horizontal plate of carbon which is adapted to an elastic capsule, this capsule in turn communicating by a flexible tube with a second capsule which may be applied to various parts of the body.

By this arrangement the vibrations from the sound source to be investigated are communicated through the medium of the air contained in the tube and capsules to the microphone plate, while the adjustment of the microphone pencil is provided for by the counterbalance. Practical experience with the instrument, however, shows that it is still too susceptible to outside disturbances, and affords an added evidence that until a more exclusive adjustment of the microphone is provided, this instrument cannot be advantageously employed as an aid in clinical demonstration. That this will eventually be done there can be but little question, and more recent experiments point hopefully to its accomplishment.

ON EDMUNDS' ELECTRICAL PHONOSCOPE. N. LADD: *British Association Reports*, Aug., 1878.—This instrument, consisting of an induction coil, an interrupter, and a rotary vacuum tube, is intended to illustrate sonorous vibrations by the production of figures of light.

Sounds producing vibrations in the diaphragm of the interrupter, in the primary circuit of the induction coil, induce at each interruption a current in the secondary coil. Therefore each vibration is made visible as a flash in the vacuum tube. The tube revolving at a constant speed, the flashes produce a symmetrical figure, as the spokes of a wheel. The number of radii are according to the number of vibrations in the interrupter during a revolution of the tube. The same sounds always produce the same figures—that is, if the revolutions are constant. Rhythmical interruptions, as in trilling the sound, result in the omission of certain radii in regular positions.

This instrument is therefore valuable for certain purposes of demonstration.[1]

An Experimental Investigation of the Structure of Fluid Columns which are affected by Sounds. R. H. Ridout: *Nature*, Oct., 1878.—These experiments were made with an apparatus consisting of two tubes so arranged that the ends from which the fluid flowed could be approximated to each other at varying angles. This was accomplished by setting two corks, each of which had a piece of glass tubing for its axis, in two holes bored in a wooden frame. Through these corks, at a right angle to the long axis of each, a longer tube or jet was passed and connected by flexible tubing with the reservoir containing the fluid. By turning the corks upon their axes the desired angle of approximation could be obtained, and with it any variety of segmentation. From his experiments the author concludes that a segmental column really consists of two jets meeting at an angle, in contradistinction to the prismatic column which assumes the form of the opening from which it passes. Of these forms the segmental column only being sensitive to sound, and the apparatus in question allowing of great variety in segmentation, a number of interesting experiments both with fluids and with gases are rendered possible. The results of these experiments the author summarizes as follows:

1. A fluid column, if sensitive to sound, consists of two columns meeting at an angle.
2. The resultant of the two columns is an expansion.
3. A column so constituted will, under favorable conditions, emit a note.
4. If excited by an external sound, it takes the same form as when it spontaneously emits the sound.
5. A column excited, as in 3 and 4, sends out an expansion at an angle (usually a right angle) to the primary expansion.
6. The component column of a sensitive column must be at such unequal distances from the sounding body that they are not thrown into the same phase of vibration.
7. A gaseous column increases in sensitiveness with the pressure, *i. e.*, the velocity.
8. A gaseous column is lessened in velocity by ignition at its origin.
9. A gaseous column when ignited is less sensitive than when unignited.

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[1] Nature, Sept. 5, 1878.

The Music of Color and Motion. N. E. Ayrton: *Nature*, Dec., 1878.—In a novel communication, made before the Physical Society, London, November 23d, the continuation of which promises matter of considerable interest, Professor Ayrton, of the Imperial Engineering College of Tokio, Japan, gave an account of an instrument devised by himself and Professor J. Perry of the same college, for the purpose of illustrating the emotional effects of color and motion combined.

The instrument consists of an arrangement of sliders, pulleys, and cords, whereby two motions, one along a vertical, and the other along a horizontal line, and each consisting of the sum of a number of harmonic motions, the period, amplitude or phase of any one of which can be varied at will, are compounded in the resultant motion of a suspended pane of glass. A black circle painted on the pane is intended to represent the moving body as projected against a wall or screen behind. The sliders controlling the motion of the pane are actuated by a revolving barrel, the periphery of which is carved according to mathematical principles, so as to give the different harmonic motions to the sliders in one revolution. The motion is further regulated by shifting the sliders either parallel to the axis or at right angles to the radius of the revolving barrel, and by the angular velocity of the barrel.

In this way the period, amplitude, and phase of the component motions of the glass, either in a vertical or horizontal direction, may be changed at will, and almost immediately.

Other kinds of periodic motions may be compounded in a similar way. Prof. Ayrton also suggests other forms of apparatus for this purpose. Numberless combinations of graceful motions producing emotional effects upon the beholder can by this means be given to a visible body. It is intended to heighten the emotional influence by means of an improved form of apparatus arranged for the blending of color with the moving body, as for example by having changing mosaics of different hues thrown upon the screen as a background for the black spot.

In its relation to the emotional effect of motion as exhibited in the harmonious blending of musical sounds, this communication is particularly interesting as foreshadowing the further development of a new emotional art, the recognition of which is indicated by the author in his description of performances of operas of "melodious motion" in Japan, the emotions being expressed simply by movements of the body. It would necessarily take a long time and much culture for the eye to appreciate the effects of moving bodies and combined colors with an emotion comparable to that felt in consequence of the appreciation of sounds by the ear, but the suggestion of the comparison, as indicated in these experiments, is one which is curiously entertaining.

Measurement of the Velocity of Sound. M. Bichat: *Journal de Physique*, October; *Nature*, November, 1878.—This very simple device for the approximate measurement of the velocity of sound, and which may be conveniently used in lecture illustration, consists in the use of the graphic method for recording the movement of two membranes at either end of a tube ten metres in length. The apparatus is thus arranged: the tube of white iron is bent upon itself in U form so that the two ends are near together. One end of the metal tube is covered by a rubber membrane; very near this end is an opening through the wall of the tube from which a piece of flexible tubing communicates with a Marey's manometric capsule. The other end of the metal tube has a stopper with an opening in it, communicating by means of a second flexible tube of the same length as the first, with a second manometric capsule. These capsules are so arranged in front of a blackened cylinder that the lever or stylus attached to each shall make a separate tracing. The speed of rotation of the cylinder is marked by the record of a tuning-fork giving one hundred vibrations in the second. The apparatus being in readiness and the cylinder set in rotation, a slight blow is given to the rubber membrane covering the first end of the metal tube. The two capsules register upon the cylinder the point of departure of the vibration from the first end, and of its arrival at the second end of the metal tube, while the tuning-fork records the time. If for instance it is found that between these two points of record on the cylinder there are three vibrations of the tuning-fork, three one-hundredths of a second have elapsed and the velocity of the sound is inferred to be 333.3m. per second. The comparative velocity of sound in various gases may also be determined by this method by the use of two or more metal tubes similarly arranged.

BRITISH MEDICAL ASSOCIATION, *British Medical Journal*, September 7, 1878.—The forty-sixth annual meeting of the British Medical Association was held in Bath early in August. The *British Medical Journal* for September 7, 1878, publishes the proceedings of several sections. We find, by a reference to Section E.—*Physiology*, that a greater part of the proceedings of that section was taken up with subjects pertaining to Otology. The President of this Section, DR. J. G. MCKENDRICK, made the opening address, on the subject of Physiological Acoustics. He remarked that this subject was now attracting a good deal of attention throughout the world; and he particularly alluded to those brilliant discoveries by our countrymen, the telephone and phonograph, as at present bringing the whole topic before the mind. The occasion afforded the President an opportunity to go into the subject of sound in general, and his address, which was of great interest, was profusely illustrated with demonstrations. Such was the interest manifested in the subject, that he was requested by a large number of the members to repeat the demonstrations on the following day.

DR. URBAN PRITCHARD presented a paper on the *Development of the Organ of Corti.*

This structure was described as being developed from certain epithelial cells lining the floor of the rudimentary ductus cochlea.

The organ of Corti is chiefly formed from a group which consists of five of these cells.

Before their contents and walls show the changes of development, these cells first lengthen so as to become columnar.

"The contents of the first, third, fourth, and fifth primary cells divide transversely so as to form the four ciliated cells of Corti (hair-cells) above, and the cells of Deiters below. The second cell does not divide, but gradually widens at its base so as to produce a triangular cell; the inner and outer sides of this cell thicken and form the rudimentary rods of Corti; at the same time a vacuole appears in the protoplasm near the base, and this enlarging gives rise to the triangular tunnel between the rods. The membrana reticularis is developed from the united tops of the primary cells. The membrana tectoria appears to be a mucoid structure analogous to the mucous layer which contains the otoliths of the vestibule. Thus it appears that the rods and membrana reticularis are developed from the walls of the primary epithelial cells, whereas the ciliated and other cells are formed from the contents; and, lastly, the membrana tectoria is a secretion from the same original epithelium.

Dr. Pritchard was complimented by the President of the Section on his successful researches on the internal ear. The president took advantage of the occasion to remark that he thought the mechanical theory of the action of the organ of Corti, as advocated by Helmholtz, was very difficult to accept, but he believed that the nerve-centres must be the real appreciative organ of sound-vibrations. Dr. Pritchard, in reply to an inquiry made in reference to the paper by Dr. Power, of London, gave it as his opinion that there could be no question as to the termination of the nerves in the hair-cells. "He believed these cells to be the actual mechanical appreciators of the sound-vibrations; the rods, superadded in the mammalia, he believed to be additional mechanical aids for the appreciation by the hair-cells of the sound-vibrations." Dr. Pritchard remarked that the membrana tectoria is a mass of tissue which is unaffected by any staining agent, and he believed that it acts as a kind of damper.

Tinnitus Aurium.—Dr. Edward Woakes, of London, contributes to the *Lancet* [Feb. 9th, July 27th, Sept. 28th] some observations on the subject of *Noises in the Head: their Etiology, Diagnosis, and Treatment.*

In the nomenclature of aural diseases, "nervous deafness" and "subjective tinnitus" have long occupied prominent places; but, as our pathological knowledge has increased, we note a proportionate decrease of cases assigned to these groups.

Referring to Dr. Woakes's contribution, we find at the outset that he disposes of the existence of so-called subjective noises by contending "that for a sound to be heard it must have a prior existence in some abnormal condition giving rise to it." He does not deny, however, that subjective conditions of the nervous system, giving origin to noises, may obtain. Dr. Woakes arranges the various forms of tinnitus according to the anatomical or physiological relations of the ear. We therefore have: 1. Labyrinthine congestion, arterial or venous, giving rise to pulsating or rushing noises. 2. Anæmia, aneurism, extra-aural causes, with pulsating noises. 3. Fluid in the tympanum or Eustachian tubes from catarrh of the middle ear, giving rise to bubbling and gurgling noises. 4. Congestion of the membrana tympani, cavity of the tympanum or Eustachian tubes, or all of them together, arising from chronic non-suppurative inflammation of the ear, causing tidal noises; and also, 5, by reflex irritation of the tensor tympani nerve from the otic ganglion, we may have noises similar to the above. "All of the above may coexist in the same patient at the same time, or may succeed each other, or be variously combined in different stages of the same case."

In connection with the first mentioned variety, Dr. Woakes presents some interesting theories as regards labyrinthine circulation. The blood-supply, he says, of the labyrinth, is from vessels given off by the vertebral artery, and they are presided over by nervi vasorum, which come from the inferior cervical ganglion of the sympathetic, thus bringing a portion of the ear into important sympathetic relationship with other parts. An increased flow of blood to the labyrinth may, therefore, be the result of any condition which may reduce the tone of these arteries, and thus dilate their calibre. Dr. Woakes believes pulsating noises may thus arise, which seem to be synchronous with the action of the heart.

We must, however, in the present state of acoustical knowledge, receive the theories pertaining to tinnitus aurium with some reserve, while acknowledging the value of these researches. To admit the assertion that the labyrinthine fluid is susceptible of continuous agitation from an ever-varying circulation is to place in doubt the well-nigh established theory of audition, which implies that the fluid in the labyrinth is incompressible. In the treatment of this class of noises Dr. Woakes has found the internal administration of hydrobromic acid to be of the greatest service.

The subject of the treatment of this affection is so instructive that we shall draw liberally from Dr. Woakes's paper. The treatment, he states, arose out of Dr. Fothergill's observations as to the antagonistical action of this drug to the aural symptoms caused by large doses of quinine when administered with it. An examination of the symptoms accompanying cinchonism will explain the *rationale* of the treatment of labyrinthine congestion by hydrobromic acid. Dr. Woakes quotes here, from Phillips's Materia Medica, the description of a person when under the full effects of quinine: "he gets loud, ringing noises in the ears, splitting headache, vertigo, amaurosis, sometimes even delirium. In animals a fatal dose of quinine has often produced convulsions and paralysis of the hinder extremities. It would appear that the lowered sensibility of parts and the diminished muscular action are due, not to direct paralysis of nerves or to any interference with muscular irritability, but to a diminished reflex action. Irritation of the skin, followed by desquamation, occasionally occurs, and cases have happened in which the whole skin of a hand, or even of a limb, has come off like a glove. It further produces in some persons great acceleration of the heart's action and of the respiration, so that palpitation and hurried breathing cause much distress." Dr. Woakes explains these symptoms by the relationship which he has shown to exist between the inferior cervical ganglion and the vertebral artery, the inhibitory nerve interfering with the circulation of the tissue-tracts supplied by the vessels over which it exercises control. Further, it is shown that full doses, toxic, of quinine impair the inhibitory function of this vaso-motor centre, and the vessels in their ramifications becoming collapsed are gorged with blood. We are enabled to map out these districts by means of the symptoms; we thus see in the excitation of the heart's action an interference with the normal inhibitory influence of the lower cardiac nerve given off by the inferior cardiac ganglion. The desquamation of the skin in the upper extremity, especially of the hand, is an example of the result of an over-supply of blood to this member in consequence of the disturbed state of the brachial artery and its branches when its inhibitory nerves, also derived from the same ganglion, are paralyzed by the drug. In the area supplied by the vertebral arteries a similar state of things is witnessed, owing to the great accession of blood resulting from this cause; and not only are the cerebellum and medulla oblongata affected by the increased amount of blood, but the labyrinth is also congested, which fact may explain the existence of vertigo and tinnitus.

The favorable results from the use of hydrobromic acid in affections having symptoms akin to those of cinchonism, as giddiness, headache, ringing noises in the head, and the like, directed attention to this remedy for the relief of tinnitus, and Dr. Woakes here dwells on the suggestion offered by the above therapeutic experience. His observations indicate a most striking departure from long accepted theories. He says: "Two important issues are deducible from the foregoing facts, viz.: that quinine and hydrobromic acid are each specifically related to the tissue tracts over whose circulation the inferior cervical ganglion exercises inhibitory control; and that therapeutically, these drugs are antagonistic, the former suspending, the latter increasing the inhibition of the vaso-motor centre constituted by the ganglion. Physiologically, we are guided to the corollary that distinct vaso-motor areas exist in the animal body, and that changes may take place in the circulation of such areas which are purely local in the first instance; that such changes are equivalent to local hyperæmias or anæmias, according as the vaso-motor influences of the area are suspended or added to; and one or another of these conditions affords the clue to a vast number of pathological states; and, further, that any true system of therapeutics must be based on the recognition of the principle now enunciated." It may here be reiterated that Dr. Woakes has found great benefit, in labyrinthine disturbances, from the use of hydrobromic acid, and the results of his experience have been confirmed by the experiences of others.

In connection with the tinnitus from the noises created by the circulation in the neighborhood of the ear, an important fact is mentioned by Dr. Woakes, viz.: "The veins which discharge the blood from the labyrinth pass into the superior petrosal sinus, and, remembering that this small canal is directly connected with two large receptacles of venous blood in the cranium, viz.: "the cavernous sinus in front and the lateral sinus behind, it is easy to see how any obstruction to venous circulation will proportionately retard the outlet of blood from the labyrinth." Thus, an overloaded portal circulation may be associated with tinnitus, the veins of the labyrinth being unable to free themselves as when in the normal state.

The abnormities of the membrana tympani, especially as associated with undue contractions of the tensor tympani muscle, are dwelt on at length, and to this Dr. Woakes evinces having directed an amount of labor which can only be appreciated fully by those who are familiar with such work. The explanations, however, given for the acoustical phenomena usually accompanying these anomalies, do not vary greatly from those already advanced by others; but Dr. Woakes's reference to the distressing and sometimes alarming symptoms which attend the presence of a live insect in the ear are of interest here, and can be best told in his own words: "The membrana tympani," he says, "and inner part of the meatus are exquisitively sensitive, a circumstance which is due to their being richly endowed with nerves from the auriculo-temporal of the fifth. This nerve, it will be remembered, supplies an offset to the otic ganglion, and this ganglion supplies the nerve to the tensor tympani; or rather, as I should prefer to describe it, the branch of the auriculo-temporal destined for the tensor tympani passes through the otic ganglion on its way to the muscle. Now, it is a trite physiological axiom that when the peripheral distribution of a sensitive nerve is irritated, reflex spasm is excited in the muscles supplied by the same nerve. It is quite clear that such a set of phenomena are established when the drum-head is tickled; in consequence the tensor tympani becomes spasmodically convulsed, the vibrations of its fibres causing the sounds of which the patient complains, while the retraction of the ossicles upon the membrane of the vestibule (foramen ovale), which accompanies this action, produces such disturbances of the equilibrating apparatus constituted by the semicircular canals, that the patient not only becomes giddy, but has a strong tendency to topple over."

The ingeniousness of the above can but excite our admiration; it is an example of the author's tendency to seek for physiological rather than physical solutions to these problems of audition. In this case we can readily believe that the crawling and fluttering of an insect in the external auditory meatus will set up vibrations in the air of the canal which can create almost any imaginable degree of distress from the sounds heard, without any undue action, whatever, of the tensor tympani muscle.

Hyperæmic conditions of the blood-vessels of the meatus, middle ear, or Eustachian tube, or all of these regions combined, are anomalies to which Dr. Woakes draws particular attention, and to them are ascribed the existence of *wave-like murmurs.*

We shall here have to hurry over ground which the author devotes much space to, as indeed he needs must do, inasmuch as these cases compose the greater number of all which are met with in practice. After a description of the retracted drum membrane which attends these conditions, and its treatment, our attention is drawn to the author's convictions, that closure of the Eustachian tube and contractions of the tensor tympani muscle are the anomalies to which the phenomena of tinnitus, etc., are mainly due. Pathological changes other than those mentioned here, the author alludes to, it is true, but it is believed they are not assigned the prominence their importance would seem to demand. The author says: "By far the largest number of cases of this kind are due to obstructions of the Eustachian tube acknowledging a catarrhal origin, and interfering with the removal of air in the tympanic cavity." Our own observations would lead us to suppose that a retracted condition of the membrane, in the vast majority of instances, was owing to pathological changes in the membrane itself, atrophy, etc., and that the non-patulous state of the tube, when it existed, was simply associated with the retraction, not its cause.

For the affections of the post-nasal space which are so frequently associated with "aural affections," the author recommends in recent instances the sniffing up of alkaline solutions, or their application by means of the post-nasal syringe. Solutions containing half an ounce of bicarbonate of soda, or chlorate of potash, or muriate of ammonia, to the pint of water, are mentioned as suitable for this kind of medication. When we made use of such medicaments, as was our practice formerly, we seldom found them, when so strong, well borne by the patient; and of late years the fear of introducing fluids into the middle ear in this manner has induced us to seldom resort to their use. Dr. Woakes does not mention the temperature of the solutions he is in the habit of using in this manner—a matter regarded by some as of importance.

"After carrying out this treatment for a short time," Dr. Woakes inflates the ear by Politzer's process on two or three successive days, which he says will replace a slightly cupped membrane in its normal site, where it will remain if the middle ear be not affected. In our experience the aurist is seldom called on to treat an affection so trivial that the treatment above described will suffice to restore the conducting apparatus to a normal condition.

The more serious anomalies of the ear coming under this head are relegated to the text-books for treatment. The author says: "The ordinary text-books on aural practice supply the details whereby to accomplish these objects." Supposing, therefore, that the methods of the text-books have been sufficient to "reduce the stenosis of the tube" and "secure as healthy a state of the tissues generally as circumstances will permit," we are recommended to use, for the purpose of "restoring the normal tension on the labyrinth," an instrument which Dr. Woakes styles the "Pneumatic Retractor." An illustration and description of this instrument accompanies his paper, and may be found in the *Lancet* for Sept. 28th. American readers, it is presumed, are already quite familiar with the main features of this apparatus, several different kinds having been described in the journals [vide *N. Y. Med. Jour.*, Sept., 1874; *The N. Y. Med. Record* for Jan. 13th, May, and Dec. 29th, 1877].

It is believed that the instruments made for this purpose in New York are better, because less complicated and less expensive than the ones recommended by Dr. Woakes, and especially so is that part of the apparatus called the ear-piece. The ear-piece used by us for the few years just past is applied by pressing it *against* the meatus opening, its olive-shaped extremity closing the meatus sufficiently to permit any desirable amount of rarefaction to take place without pain from the ear-piece itself. One size fits nearly every meatus. Dr. Woakes's ear-piece, however, is similar to Seigel's, and requires to be fitted, by the use of tubing drawn over it, to the *inside* of the meatus, which is nearly always a painful procedure. Space will not permit allusion to all that is claimed for this instrument or the method of its application; the latter, however, does not differ materially from the methods recommended in this country. Dr. Woakes regards the drawing out of a sunken membrane and the detaching of adhesions as likely to be followed by an improvement to hearing, as well as by a proportionate diminishment of the noises and giddiness.

The use of instruments for the above purpose has not, in our hands, been attended by the good results that we had at the outset hoped to obtain. In exceptional cases they have been of benefit to the patient, perhaps, by loosening adhesions which interfered with the movements of the conducting apparatus. For diagnostical purposes, the instrument which produces rarefaction and condensation by means of the contraction and expansion of a small elastic ball held in the fingers, answers most purposes, and, it may be added, has been found very serviceable in practice. Dr. Woakes refers to the rupture of the membrane which sometimes takes place during the operation of drawing it out. We think these ruptures "with clean-cut edges" do not occur from the loosening of adherent membrane, but that they are the result of the giving way of a membrane greatly weakened by atrophy, etc., nor can we agree with the author in the belief that "the existence of this perforation of the membrane is in every way an advantage, as it allows the better medication of the tympanic cavity." On the contrary, the perforation may be the means of setting up acute inflammation, the results of which are not easily foretold; and in no way known to us can hearing be improved by a perforation of the membrane.

On the whole, the contribution of Dr. Woakes is one of the most useful that has appeared in the English journals for a long time; and although we may differ from him on some still mooted points, we must regard his researches as an honest effort in the right direction, and as an indication of the advance of otological science.

OBSERVATIONS ON TUMORS OF THE AURICLE, by M. BIAUTE, Interne de l'Asile de La-Roche-Grandon. Service de M. le Dr. Henri Bonnet. *Annales Médico-Psychologiques*, 1877.—According to Franz Fischer (*Annales Méd.-Psychol.*, 1850) the insane may present two varieties of disease of the auricle of the ear: 1. Serous œdema; 2. Sanguineous tumors—the so-called othæmatomata.

The first are often ambilateral, and are colorless, painless, and rapid in their development as well as in their disappearance.

The second, the othæmatomata, are unilateral as a rule, of a peculiar color, painful and last longer than the previous form, their contents are reproduced rapidly after either an artificial or an accidental evacuation, and there is always resultant deformity of the auricle.

It is not necessary to treat the serous œdema of the auricle, but the othæmatomata should be combated, according to Fischer, by leeches, incisions, and stimulating lotions. These tumors are not peculiar to any one form of insanity, they are *never* the result of traumatic causes, but are the products of passive hemorrhage and of active effusions, the causes of which are to be found in a pathological condition of the central organs of the nervous system.

According to Marcé (*Annales Méd.-Psychol.*, 1859), the othæmatomata may be ambilateral, developing at the same time on both sides, are coexistent with other partially inflammatory and apoplectic affections, are not amenable to any kind of treatment and their duration is as long as four months. The case reported by Marcé was observed in a patient affected with melancholia.

According to M. Foville (*Annales Méd.-Psychol.*, 1858), the seat of the effusion is beneath the perichondrium, the latter being detached from the cartilage. The same author holds that these tumors are common in males, but not in females, no matter of what form the insanity may be, and that such tumors are always found in incurable subjects, excepting in cases to be considered altogether exceptional. Their formation is very rapid, not being detected usually until completely developed. Sometimes one ear, sometimes both are affected, but in the latter instance the tumors do not develop simultaneously. They terminate in induration and puckering of the auricle. Finally there supervenes in the head of the patient a condition similar to that observed in animals after the great sympathetic has been severed, or after removal of the superior cervical ganglion. M. Foville, however, recognizes the fact that these sanguineous tumors of the auricle are sometimes observed in the sane.

According to Mons. Dumesnil the prognosis is to be considered always unfavorable for the recovery of the patient's reason, although they may be present in cases of acute dementia. In ten cases, eight times the disease was connected with general paralysis, and the effusion occupied the seat assigned in the paper of M. Foville, *i. e.*, beneath the perichondrium. Their course should never be considered as external, since they are never observed in curable forms of insanity nor in epileptics, notwithstanding their liability to fall and the constant bruises to which they are exposed. True othæmatomata are always the result of general internal causes, since it is not shown that the sanguineous effusions observed in the auricle of boxers, and of children who have been beaten, are of the same kind as those seen in insane paralytics.

Although it is uncommon to hear any account of this disease excepting from those having under observation asylums for the insane, yet in 1876 M. Duplay delivered a clinical lecture on othæmatomata, in the hospital St. Louis. The patient brought before the class in this instance was fifty-one years old, a cartwright, of intemperate habits. The tumor developed on the right side slowly, without definite causes, ran its course, was treated by puncturing, but deformity supervened. In his treatise on surgical pathology, Duplay also gives the seat of the effusion as being between the cartilage and the perichondrium, and he assigns it to both traumatic causes and to those of a general and internal kind dependent upon a central nervous lesion.

According to the thesis of Kuhn, who based his observations on experiences in the asylum at Maréville, othæmatomata are more frequent in the paralytic insane than in any other form of insanity, in men more commonly than in women, in the proportion of 52 to 10, and more frequently seen on the left than on the right side.

M. Henry Bonnet, in speaking of hæmatoma of the auricle, as occurring in the course of general paralysis, says: "These tumors are veritable congestive apoplexies, which arise in consequence of a gradual degeneration of the sympathetic. There results a turgescence of the vessels of the ear, and at last an apoplexy; it is, in fact, a pathological repetition of the experimental section of the nerve above the superior cervical ganglion. We must, however, keep in mind a fact which, when viewed physically, is very important, viz.: that since successive irritations and the progressive alteration in the superior cervical ganglion has led to secondary inflammation at the base of the skull, in the meninges and the brain, this apoplexy in the auricle becomes advantageous to the patient, since the hemorrhage is spent upon the posterior auriculars, coming from the middle meningeal. If this did not occur, either a meningeal or cerebral apoplexy would ensue, or at least an intense congestion, the continuation of which would produce death. Excepting in cases of general paralysis, these tumors never occur, excepting in chronic conditions, and are favorable to a prolongation of life."

M. Biaute then describes his own cases, which he observes differ in some respects from those given by the above-named author from whom he has quoted.

Since the beginning of 1874 five patients under the care of Biaute have been affected by othæmatoma, two males and three females. There were in all seven tumors, the ambilateral ones being in the females. In this entire number of five patients only *one was suffering from general paralysis.*

It will be seen at once that these observations differ from those of Fischer in that in some instances the tumors were ambilateral. Respecting treatment, since it will have no influence on the duration, nor in preventing deformity, it is best to abstain from such interference according to Biaute, as, after puncture or incision the auricles have been destroyed as observed by Henry Bonnet in Maréville, whereas in non-interference no such result has ever been observed.

Biaute's experience is different from that of Marcé so far as the synchronous occurrence of double tumors is concerned, and it also differs from M. Foville's respecting the relative occurrence in males and females, since Biaute observed five instances in females to two in males.

These tumors do not always occur in the same form of insanity. In ten cases of M. Dumesnil, eight occurred in general paralysis. In M. Biaute's cases only one in five was affected with general paralysis—only one tumor in seven.

Violence has nothing to do with the production of othæmatoma, as may be seen from those cases in which the tumors are ambilateral, as similar violence is not likely to be applied to both ears at the same moment.

M. Biaute's five cases are then given in detail, and a tabular *résumé* closes the valuable paper.

OTHÆMATOMA OF THE AURICLE IN THE INSANE, by M. le Dr. Bouteille: *Annales Médico-Psychologiques*, Juillet, 1878.—After alluding to the value of the paper of M. Biaute, and to the general importance of this subject, M. Bouteille proceeds to give a sketch of the literature of the subject, and states that there are still two views held as to the nature of this disease of the auricle: one, that it is a congestion with hemorrhage, and the other, that it is due entirely to traumatic causes.

We are informed that the first systematic study of othæmatoma in France was conducted by Ferrus in 1838. Reference is then made to the distinguished labors of Foville (1859), alluded to at length in the preceding paper, and to those of Delassiauve and A. Motet in the same year, and which appeared finally in the *Gazette hébdomadaire.* Reference is then made to the works of

Yung, Leubscher, Foville, Mary, Neumann, Schmaltz, Fischer, Renaudin, Merlan, Marcé, Delassiauve, Morel Dumesnil, Kuhn, Ducros, Castelain, Bonnet, and Biaute, all of whom incline to the opinion that othæmatoma is symptomatic of disease of the nervous centres.

Mons. Bouteille then cites the authorities on the other side, among whom he places himself, who believe that these tumors are produced only by traumatic causes.

Thus, Ferrus supposes these tumors are produced in the insane paralytic by too long decubitus in one position, and also to the turning and rubbing in bed, which ensues when these patients are turned over by their attendants. This opinion as to traumatic origin is then shown to be held, by quotations from their writings and published cases, by Prof. Joire, MM. Lunier, Belhomme, Ingels, Vanvers, and Prof. Folet. M. Bouteille then alludes, in further proof, to an epidemic of othæmatoma, which was observed at Lyons in 1859, and which disappeared simply by changing the attendants. Griesinger denies their occurrence in well-managed hospitals and where the attendants are well watched.

Leutz of Froidmont, Petit of Nantes, Dagron, and Broca, are then quoted in support of this theory, and M. Bouteille then cites several cases under his own observation, in which the traumatic origin was indubitable, though occurring in the insane paralytic. Some authors, Laycock, J. Hutchinson, and Claverie, have declared that othæmatoma is due to prediposing causes and to the exciting cause, the former being congestion of the brain and turgescence of the capillaries, and the determining cause violence.

Were it purely due to the cachexia of insanity, othæmatoma should be more common among the insane, since M. Bouteille holds they all more or less possess the predisposition to it, such as torpor of the nervous centres, general cachexia, diseases of the circulation, debility of constitution, etc. Cudden, Geherve, de Vernech and Virchow are thus alluded to as opposed to the theory of congestion and hemorrhage, as productive of this form of tumor of the ear.

This most interesting paper then closes with the following sentence: "Without wishing to absolutely reject the theory of predisposing causes, we believe that they do not possess the importance attributed to them, and that othæmatoma never appears excepting in those who receive some violence on their auricles, either self-inflicted or from others. This disease has no prognostic value in the consideration of the mental diseases."

THE EARLY FORMATION OF THE AURICLE IN THE HUMAN EMBRYO. LOEWE: *Archiv für Ohrenheilkunde*, Vol. XIII., p. 167.—On a human embryo, 1 ctm. in length, Loewe has studied the development of the auricle. Beneath the oval fissure, and low down nearly to the spot where the upper extremity is given off, the entrance to the meatus was seen like a torn rent in the integument, with an anterior and posterior edge. On the anterior edge of this opening was a beginning of the incisura intertragica with the tragus and antitragus. The spina helicis could also be made out a little in front. The special configuration of the auricle is referred by Loewe to peculiar notches in the edge of this opening of the meatus auditorius externus. In the specimen examined, the upper and lower extremities showed no attempt at separation into upper and lower portions, nor was there any sign of the feet; but all the important parts of the auricle could be found, showing that this structure is formed first.

PARACENTESIS OF THE DRUM-HEAD. DR. LAIDLAW PURVES: *London Lancet*, March 30, 1878.—This paper on the *results of one hundred cases of paracentesis of the membrana tympani* was read before the Royal Medical and Chirurgical Society.

The patients operated on, eighty-three in number, were, it may be inferred from the report, suffering from various affections of the ear. Dr. Purves employed several methods of procedure—the knife, the trephine, acids, oils, and ointments, pancreatine, and the galvano-cautery; the latter, combined with pressure and ointments, is preferred for maintaining or attempting to maintain a permanent opening, but the maintaining of such is exceptional.

The frequent repetition of the paracentesis, Dr. Purves states, causes a permanent thinning at the spot perforated, which acts to a certain extent in the same way as a perforation.

Forty-six persons operated upon are reported as benefited temporarily or permanently.

One-fourth of the cases of tinnitus were benefited. In acoustic affections no improvement occurred. Of thirty-nine cases of cataractous drums, twenty-three were improved; five out of seven relaxed drums improved. Of twenty-one paracenteses for the removal of substances from the cavity, fifteen were benefited.

The practice of attempting to *cure* deafness by means of making and keeping open a hole in the membrana tympani, it would appear from the above, is still occupying the attention of a portion of the English aurists.

Dr. Purves states that in acoustic affections no improvement occurred, although one-fourth of the cases of tinnitus were benefited. This result would appear somewhat contradictory, unless we could regard tinnitus as other than an acoustic anomaly. We cannot but regret the introduction into our already inexplicable aural nomenclature of such a term as "cataractous drums." The term would be no better if it read "drum-heads," which is meant, to judge by the concluding portion of the sentence which says, "five out of seven relaxed drums improved." This last statement that "five out of seven relaxed drums (drum-heads?) improved" indicates a result we should scarcely have expected after reading above that "the frequent repetition of the paracentesis causes a *permanent thinning* at the spot perforated, which acts to a certain extent in the same way as a perforation."

Mr. Dalby, who was present at the reading of Dr. Purves's paper, said that he had seen the late Mr. Hinton, in 1870 and 1871, perform the operation of paracentesis three or four hundred times. His own opinion, however, had changed since then. In a paper on *Non-Purulent Catarrh of the Middle Ear*, read before the society more than five years ago, he had pointed out that in many of the conditions in which paracentesis was performed there was no fluid in the tympanic cavity, but either chronic thickening of its lining membrane or inspissated and altered secretion. In such cases paracentesis could do no good. He believed that in time the membrane would come to be regarded as a protective membrane to the inner ear, and as a ligamentous support to the ossicles in the tympanum. Mr. C. Broake stated in connection with the subject that, in 1817–18, Sir Astley Cooper had perforated the drum-head of both his ears, for deafness from enlarged tonsils, by means of a sharp three-cornered probe. He said the operation was attended by complete relief and even unpleasantly acute sense of hearing. He did not know how long the openings remained patent, but many years afterwards Mr. Toynbee found no perforation. —Dr. R. C. Brandies, who took a part in the discussion of the paper, may be regarded as entertaining opinions which are held by a large number of persons who practice in aural surgery, and his remarks are on that account of interest here. He said that "in his experience paracentesis of the membrana tympani was an operation which, if performed when plainly indicated, was always attended with beneficial results." This expression, although rather conservative, is soon followed by language which manifests a confidence in this kind of aural surgery which is more likely to be founded upon theory than experience. Dr. Brandies says: "Not only is the division of the drum membrane serviceable in such cases in which there is a morbid secretion or an obstruction in the normal aëration of the tympanic cavity, but it is called for in cases where there is a disturbance of the natural contour of the membrane, or an anchylosis of the chain of bones, or an impaction of the stapes in the fenestrum rotundum [fenestra ovalis is evidently intended]. In these cases the paracentesis of the membrane in the posterior inferior quadrant will serve to admit the sound-waves directly into the tympanum, whence they can reach the lamina membranacea covering the fenestrum rotundum [*sic*], and thus reach the labyrinth." The doctor recommends the use of the aluminium canula devised by Voltolini, for maintaining a permanent opening in the membrane, its mere division being regarded as of temporary service only.

Mr. Cumberbatch said, after hearing the foregoing, that one point to be borne in mind was the possibility of doing damage to any little hearing the patient might have, and agreed with Mr. Dalby as to the necessity of restricting the operation to cases of fluid accumulation in the tympanic cavity, and that before operating the surgeon should consider whether the chances of doing good were not counterbalanced by the chances of doing harm.

INJURY TO THE EAR FROM FRACTURE OF THE SKULL.—The *London Lancet* for March 9, 1878, reports a case of fracture of the skull, with discharge from the ear. DR. CAMPBELL, of the Liverpool Northern Hospital, had charge of the case. The patient was a sailor, aged twenty-two, who had fallen headlong on the deck of his ship a distance of fourteen feet. Blood immediately issued from the mouth and nose, but not from the ears. From the right ear, however, there was a flow of clear fluid. He was insensible for a short time only. There was found to be a small compound depressed fracture of the frontal bone on the right side posteriorly. The fluid continued to flow from the ear for six days, a portion of the time at the rate of over one pint daily; it gave a copious precipitate with nitrate of silver. The hearing on that side was impaired. The pupils were dilated, equal, normally sensitive; the vision was double. Pulse 48, and of moderate volume.

On the eighth day the patient was violent in his actions and delirious. On the eleventh day the discharge from the ear recommenced, and continued until his death, but was not as copious as before.

On the thirteenth day he had great pain in both ears, and on the fourteenth he was again violent, but became suddenly comatose and died.

At the *post-mortem* there was found a saucer-shaped depression of bone three-quarters of an inch in diameter just below the anterior part of the right temporal ridge, and a fissure was discovered in the squamous portion of the temporal bone running from before, obliquely backward and downward into the petrous portion, where it implicated the internal auditory canal. There was separation of the fractured bones, at one part, of one line and a half. Pressing upon the middle and third right frontal convolutions were sharp spicules of bone which were surrounded by a large clot of recent formation. The hemorrhage was outside the dura; the brain was uninjured, but its vessels were congested. The membrana tympani of the right side was open.

The *Lancet* for March 30th reports another case at St. Mary's Hospital under the care of Mr. James Lane and Mr. Field. A man aged twenty had fallen twelve feet, striking his head against some stone steps. He was insensible when picked up, and bleeding from the mouth and nose. Consciousness soon partially returned, but he was in a state of extreme collapse.

No outward evidence of fracture existed, but there was ecchymosis of left eyelids and also beneath the ocular conjunctiva. He slowly rallied from collapse, when he vomited blood, the nose continuing to bleed. During the first night he was violent and delirious, but conscious of his acts when reasoned with.

Until the fourth day he was in a torpid condition, with occasional restlessness from severe pain in the head, and during this time he vomited blood frequently. There was no paralysis; temperature normal. Pulse ranged from 48 to 70.

He was found to be quite deaf in the right ear, and partially so in the left. From this time the patient gradually recovered, so that at the end of four weeks he was able to go about. Deafness, however, remained complete in the right ear, although the hearing in the left had much improved.

Mr. Lane believed that there had been in this case a fracture of the anterior fossa of the base of the skull, implicating probably the orbital plate on the left side and the cribriform plate or cells of the ethmoid, and perhaps the sphenoidal sinuses. Such a fracture would account for the great ecchymosis in left orbit and lids, and for the bleeding from the mouth and nose. He thought the head-symptoms depended on "cerebral irritation," and that the oozing of blood by the mouth and nose prevented injurious compression, etc.

There was no oozing from the ear to indicate fracture of the petrous portion of the temporal bone, and so account for the deafness. Mr. Lane thought it not impossible for such a fracture to take place without rupture of the membrana tympani, in which case the blood could escape by the Eustachian tube.

The urgent symptoms of this case having subsided, Mr. Field undertook the treatment for his deafness.

Mr. Field states that there was no sign of injury to the membrana tympani, and that the patient could not hear the ticking of a watch in the right ear. He regarded the presence of effusion as the cause of deafness. The treatment consisted in the application of blisters over the mastoid process, six leeches in front of the tragus, and the administration of three grains of iodide of potassium three times a day.

In four days the patient could hear the watch five inches from the right ear; the treatment was continued. In ten days' time he could hear at thirty-six inches, and at the expiration of a month his hearing was restored.

In the first case mentioned, the great quantity of "clear fluid" which flowed from the ear is of interest, although it seems difficult to imagine where such a quantity came from. The interest in this class of cases would be greatly increased, for the aurist at least, if the impairment of hearing could be noted more definitely than by "hearing impaired," for the impairment may have existed before the accident. From the *post-mortem* at least we have a right to expect some exact information on a point which is of such importance as the impairment of an organ of special sense: but the ear seems not to have been examined further than to ascertain that the membrane was "open." We are thus left without any definite knowledge as to the degree of deafness caused by the injury, or as to the seat of the lesion itself, further than the fact that there was a fissure implicating the internal auditory canal.

We cannot, therefore, regard cases which are reported in this manner, as imparting the information to the profession which their importance would seem to demand.

The case reported by Mr. James Lane and Mr. Field resembles the former one in many particulars; with its otological bearings, however, we are here most concerned. And first of all it is to be regretted that the record of this case only shows as regards the hearing, that four days after his admission to the hospital he was "quite deaf in the right ear, and partially so in the left." It may seem hypercritical to refer to the records of a general hospital in this manner, but these cases are reported in a way to call special attention to the symptom of deafness.

Mr. Field does not inform us on what ground a diagnosis of effusion was based, but presumably there were good reasons for the diagnosis. We cannot, however, but think that he should have given the symptoms which directed his attention in that direction, especially when occupying the position of an instructor in medicine. Was the conducting mechanism at fault, or was the lesion confined to the inner ear?

In this case, as well as in the first one, we are not led to suppose that any deafness existed prior to the injury, although the inability to hear the ticking of a watch is not of unusual occurrence. The test of a ticking watch, moreover, is a fallacious test at best, for the important thing to ascertain is, how well can the voice be heard.

The rapid improvement in hearing, and the successful termination of this case, increase the desire to have a more definite idea of the lesion than "effusion" conveys.

REMOVAL OF A HARD RUBBER "EYELET" FROM THE MIDDLE EAR, WHERE IT HAD REMAINED FIVE YEARS. DR. R. VOLTOLINI: *Monatschrift für Ohrenheilkunde*, August, 1878.—Dr. Voltolini, in the August number of the *Monatschrift*, publishes the history of a case which is of sufficient importance to be reported here somewhat in detail.

In July, 1873, the patient, a boy nineteen years old, consulted Dr. Voltolini for relief from tinnitus aurium and deafness of quite rapid development. As no other remedial procedure offered any prospect of benefiting the patient's hearing, Dr. Voltolini made an opening in the right drum membrane, and, in order to prevent it from closing again, introduced a hard rubber eyelet which he had had constructed specially for this case. This eyelet differed from the one invented by Politzer, and manufactured by Leiter of Vienna, in that it possessed a flaring end like that of an ordinary spool used for cotton thread. By means of this flaring end Voltolini hoped to prevent the eyelet from slipping into the cavity of the middle ear, and to render the attachment of a thread to the instrument unnecessary. The exact length of the eyelet was three millimetres, and the breadth of the flange or flaring end one millimetre. Some days after the instrument had been successfully introduced into the artificial opening in the drum membrane, Voltolini discovered that it had fallen into the tympanic cavity. Every possible effort was made to extract the eyelet from the middle ear, but without success. Voltolini therefore decided to allow the foreign body to remain where it was. The pain in the ear soon subsided, and the patient, who lived at a distance, was allowed to return home. On the 28th of June of the present year (1878)—that is, five years after the occurrence of the accident—the patient again presented himself. His hearing was no worse than it had been five years before; if anything, it had improved slightly. An examination of the right ear showed that the drum membrane was whitish and opaque, except in a few spots where it still retained its natural transparency. By reflected sunlight it was easy to distinguish the presence of a blackish foreign body in the middle ear, which of course could be nothing else than the hard rubber eyelet. The patient said that he had experienced no discomfort whatever from the presence of this comparatively large body in the tympanic cavity. Dr. Voltolini made a crucial incision in the membrana tympani, and by means of a delicate hook, adapted to such purposes, readily extracted the eyelet. It was found lying in the posterior part of the cavity, at exactly the same spot where it had fallen five years previously, and was enveloped in a little transparent mucus. No change whatever had taken place in the instrument itself. On the day following the operation, not a trace of inflammatory reaction could be detected in the membrana tympani.

OTALGIA INTERMITTENS. DR. R. VOLTOLINI: *Monatschrift für Ohrenheilkunde*, Juli, 1878.—DR. R. VOLTOLINI reports the case of a woman, twenty-nine years of age, who from her earliest childhood had repeatedly suffered with intermittent fever. Her home was situated in a decidedly malarial region, and, owing to the poverty of her parents, her nourishment was both bad and insufficient. Among her other ailments she had suffered considerably from an affection of the throat, which finally led, about six months before the time when she consulted Dr. Voltolini, to complete loss of the voice. A larnygoscopic examination showed that this condition was due to paresis of the vocal cords. The constant and the induced currents of electricity were employed, and in the course of a few months the patient recovered her voice permanently. Under the use of quinine and good nourishment the malarial manifestations ceased and the woman seemed to be in a pretty good condition of health. Quite recently, however, she complained of attacks of severe pain affecting the left side of the head. During these attacks, which came on at about the same hour every other morning, the auricle would become so tender that the patient could not lie upon the left side. She complained of ringing in the ears. There was also a decided diminution of the hearing during the paroxysm. In addition to these special symptoms each attack was characterized by a distinct chill followed by a sensation of heat and profuse sweating. The paroxysms furthermore were ushered in by a keen sense of hunger. Quinine speedily put an end to the attacks.

PERIOD AT WHICH THE FŒTAL CONDITION OF THE MIDDLE EAR (PRESENCE

OF A GELATINOUS MASS) DISAPPEARS. DR. GELLÉ: *Gazette Médicale de Paris*, 24 Août, 1878.—During the past two years Doctor Gellé has on various occasions demonstrated to the members of the *Société de Biologie* the existence, during the period of fœtal life, of a gelatinous mass filling the middle ear. This mass, he believes, is due to an œdematous infiltration of the mucous membrane lining the inner or labyrinthine wall of the tympanic cavity. As soon as respiratory movements are regularly established, air very speedily takes the place of this gelatinous mass. On the other hand, if the respiratory movements are insufficient, the mass may persist. The important question—especially from a medico-legal standpoint—suggests itself, how long a time is necessary for the complete displacement of this mass? To answer this question it would be necessary to attend the delivery of some animal, and then at a given moment, after the birth of the young, destroy the newly-born animal and ascertain the condition of the middle ear by dissection.

Good fortune threw such an opportunity in Dr. Gellé's way, and he made haste to improve it. A cat gave birth to several kittens in his presence, in the physiological laboratory of the Faculty of Medicine. At the end of half an hour he killed one of the kittens. The animal had mewed, and had breathed naturally; the lungs were found at all points well filled with air. The tympanic cavities were also found entirely free from every trace of gelatinous substance. In other words, half an hour of regular respiratory movements had sufficed to accomplish the transformation from the fœtal state to that of life.

ATRESIA OF THE FORAMEN OVALE, AND ABSENCE OF THE STAPES. ZUCKERKANDL: *Monatschrift für Ohrenheilkunde*, Juli, 1878.—In the imperfectly developed and exceptionally small petrous bone of a new-born child, Zuckerkandl found the greater part of the roof of the Fallopian canal wanting. From the position of the internal meatus a funnel-shaped groove, only covered for a short distance at its narrowest portion, opened upon the upper surface of the petrous bone, from here ran, still as an open groove, towards the tegmen tympani, and then at a right angle backward. In this groove the facial nerve lay covered simply by dura mater. At the spot where the Fallopian canal should make two sharp turns in the petrous bone was, in this preparation, a cavity in the bone which communicated through an opening with the tympanum, and the course of the nerve was along a groove on the posterior tympanic wall, ending in three blind depressions near the eminentia pyramidalis. The course of the acusticus had nothing in common with the facialis, as it ran along almost on the inferior surface of the petrous bone and ended at the base of the cochlea in a lamina cribrosa not more than one-third of the normal size.

Examination of the tympanum showed that there was no foramen ovale, no promontory, no eminentia pyramidalis. On the labyrinth wall was a depression 8 mm. long and 7 mm. high, with smooth walls; at the bottom of this depression was a small opening leading into the cochlea. No trace of the foramen ovale could be seen, although the labyrinth wall was thinner at the spot where it should have been than it was elsewhere. The cochlea and vestibule were only one-half as large as normal. On examining the interior of the labyrinth, where the foramen ovale should have been, the same appearance was seen as though the stapes was in position, namely, a distinctly marked outline of the base of the stapes surrounded by a very delicate white wall. The appearance was the same as that found where the base of the stapes is anchylosed with the labyrinth wall. It should be remembered that from the tympanum no trace of the stapes could be recognized.

Zuckerkandl considers that the condition of the Fallopian canal in this case is what would be expected from an arrest in the development of this part, as has been shown by the works of Rüdinger. In regard to the atresia of the foramen ovale, and the peculiar appearance of the base of the stapes imperfectly formed in the labyrinthine wall, he considers this a confirmation of the view of Gruber, that the stapes is formed by gradual separation from the labyrinthine wall; in this case the separation being shown by a thinning of the labyrinthine wall around the base of the stapes, but the process had gone no further.

OBSTRUCTION OF THE EXTERNAL MEATUS AND TYMPANUM. *Idem. Ibid.*—In the skull of a man, aged forty, the right meatus was nearly closed by an osseous mass slightly concave on its external surface. Below this was a small opening, 1 ctm. long, 2 ctm. wide, and 2 ctm. deep, through which a bristle could be passed—the only remains of the meatus. The membrana tympani, ossicles, and tympanic cavity were all wanting, the osseous mass of the meatus extending directly into the petrous bone and showing within its substance, in a few spots, cells. The canal of the tensor tympani was wanting, but the osseous Eustachian tube was 1 ctm. long, but closed at the tympanum by the osseous growth. The internal auditory meatus was somewhat smaller than normal; the osseous labyrinth, however, was normal. As Zuckerkandl well says, the case demonstrates how extensive and deep the changes in the ear are with atresia of the external meatus. He refers the changes in this case to excessive development of the labyrinth wall and deficient resorption. It is not stated what the history of the case was, whether the growth was pathological or congenital.

CONTRIBUTIONS TO THE NORMAL AND PATHOLOGICAL ANATOMY OF THE EAR. BÜCKNER: *Archiv für Ohrenheilkunde.* Vol. XIII., p. 2.—From an examination of 1,178 skulls of different ages and various races, Bückner concludes that

"The defects of ossification in the anterior wall of the external meatus are most commonly found in the skulls of children between the ages of one and five years; after the fifth year they become more and more rare.

"In adults these defects in the meatus are more common than is generally supposed; they exist in 19.2 per cent. of all cases.

"The skulls of females show these defects in the meatus more commonly than those of males.

"Defects in the anterior wall of the meatus of adult skulls are found to be equally common in all races."

He finds that the development of the osseous meatus from the tympanic ring takes place, as described by previous authors, by the growth and projection outward of the tubercula tympanica antica and postica, which gradually unite, leaving an opening through the anterior wall of the meatus. The time of development of these tubercles from the tympanic ring varies between the seventh month of fœtal life and the fifth month after birth. The posterior tubercle is much the larger of the two. The union of the tubercles occurs generally in the second year, although occasionally in the first. The size and shape of the opening left in the meatus varies very much; the more common form is an irregular oval or crescent with jagged edges. Almost always the defects in the two sides of the same skull are alike.

The openings in the tegmen tympani, first fully described by Hyrtl, although mentioned by previous authors, have been made the subject of investigation by Bückner, for the purpose of discovering the cause of the deficient ossification at these points. The causes given by previous authors have been, by Hyrtl, a lack of lime salts during pregnancy; by von Troeltsch, a long-continued use of Valsalva's inflation of the tympanum; and by Luschka, rarefaction of the bone by the pressure of the Pacchionian bodies upon the tympanic roof.

Dr. Flesch suggested to Bückner that these rarefactions of the tegmen tympani and of other parts of the skull were due to the pressure exerted by the enlarging brain upon the bone, and investigation showed really a marked connection between the development of the impressiones digitatæ and juga cerebralia and the development of the roof of the tympanum. Of 120 skulls examined, 44 showed rarefactions of the tegmen tympani; of these 44 cases 36, or 81.8 per cent., showed very marked impressiones digitatæ. It was also found that in 73 per cent. of the cases in which there existed a thinning or opening in the roof of the tympanum, there was also a thinning or opening in the bone of the orbit, and in many of these cases the upper wall of the carotid canal was also very thin. In 36 of these cases the tegmen tympani showed distinct openings, in the others it was extremely thin. The seat of the openings was above the head of the hammer, a little towards the sutura petroso-squamosa.

Among the 120 skulls examined, 4 showed an opening between the tympanum and carotid canal, and 3 an opening between the tympanum and fossa jugularis. Among the curiosities found were one case of dehiscence of the mastoid cells in an adult, the rarefied spots appearing as a delicate framework enclosing numerous fine openings on the external surface of the mastoid process: two cases of dehiscence of the squamous portion of the temporal bone, one from a child one and a half years old, showing a delicate osseous framework enclosing several openings on the squama and corresponding with the deepest part of an impression of the brain, the other from a man thirty-two years of age, where a similar condition existed on both sides; a third skull from an adult showed depressions and openings in the upper wall of the orbit, in the greater wings of the sphenoid, in the sella turcica, in the tegmen tympani, and in the wall of the right sigmoid sinus; these depressions corresponded with and apparently were produced by the Pacchionian bodies, which were very numerous. Similar openings and depressions were found in another skull, together with a large opening through the tympanic roof. One skull showed a slit-like opening in the sutura petroso-squamosa which led outward toward the mastoid cells, although it was not determined whether it communicated with these cells. In the skull of a negro small openings were found in both glenoid fossæ, communicating with an air cavity.

Bückner's conclusions are that the openings in the tegmen tympani and in other parts of the skull are in the majority of cases produced by pressure of the brain.

In the meatus of a child one year old Bückner found a separate small cartilage, and in five other cases, between three weeks and one and a half years of age, the same separate cartilage was found to be constant. At the point where the cartilaginous extension of the auricle in the meatus is replaced by soft tissues a small hook-shaped separate cartilage was found from 1 to 1¼ ctm. long. In this separate cartilage Bückner sees an analogue to the third cartilage which is found in some animals.

CASE OF FATAL MENINGITIS FOLLOWING CARIES OF THE PETROUS BONE. DR. F. C. HOTZ: *Chicago Medical Journal and Examiner*, October, 1878.—The patient, a man 42 years of age, had been affected with a purulent discharge from the left ear for a period of fifteen years. Severe pain supervened. Dr. F. C. Hotz, whom he consulted, found tenderness behind the ear and slight œdema of the mastoid integuments; pus in the external meatus; deeper in, a large, soft polypus, which, upon removal with the snare, was found to spring from the promontory by a slender peduncle; membrana tympani and ossicles destroyed. By means of the probe it was ascertained that the tympanic cavity was extensively carious. The pain did not cease until about three weeks after the removal of the polypus; the patient, however, still complained at that time of dizziness and a strange, heavy feeling in his head. Contrary to the doctor's advice, the patient visited the country on business, and died, two weeks subsequently, of meningitis.

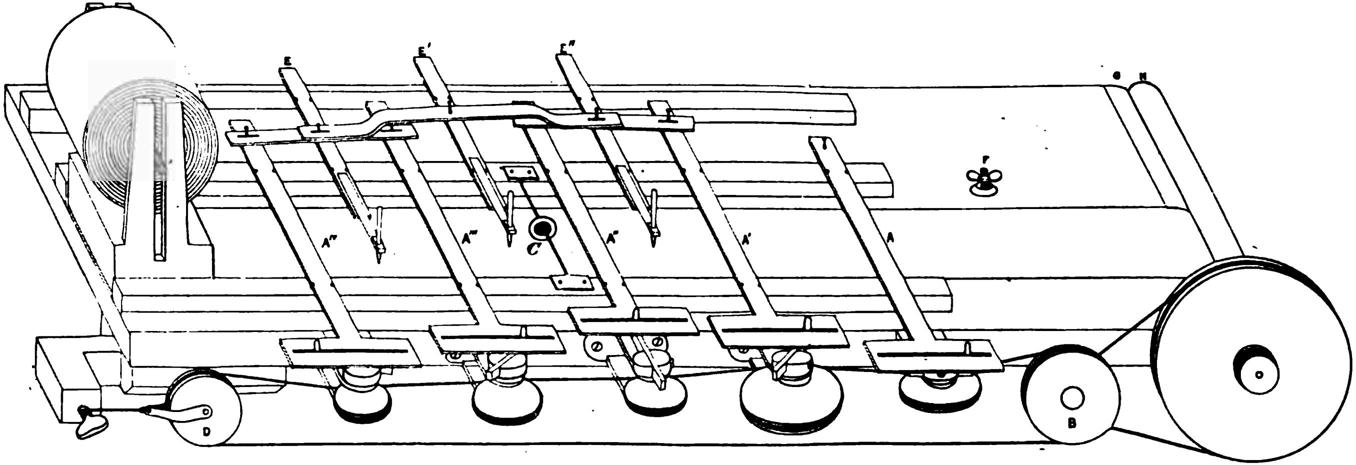

Plate 1

A MACHINE FOR DRAWING COMPOUND HARMONIC CURVES.

By PROF. E. W. BLAKE,

BROWN UNIVERSITY.

HARMONIC curves possess great importance, since they represent to the eye the circumstances of motion of bodies in a state of vibration, and hence apply not merely to the pendulum, and to musical instruments when giving their tones, but also to the particles of air during the transmission of sound.

A *simple* harmonic curve is traced when a point, vibrating as a pendulum, marks its path on a strip of paper moving with uniform velocity in a direction at right angles to the plane of the vibration. If the point be impressed simultaneously with the vibratory movements belonging to two or more pendulums, of different rates but in the same plane, the curve described on the paper will be a *compound* harmonic curve. Fourier has shown that all periodic curves whatever may be considered as made up of a combination of simple harmonic curves, in general, infinite in number, and hence such curves are important in pure mathematics. It is, however, in Acoustics that they possess the most immediate interest.

NOTE.—Since this article was in type, a paper on the Synthetic Examination of Vowel Sounds, by W. H. Preece and Augustus Stroh, was read before the Royal Society, as appears from an abstract published in "The English Mechanic and World of Science" of March 7th.

This paper alludes to a machine invented by the writers and called by them a Synthetic Curve Machine. No description of this apparatus is given, but the end attained by it is identical with that reached by the machine here described, and it will be interesting to compare the methods of these two independent solutions of the same problem.

My own apparatus was completed Nov. 24, 1878, and the above description was in the hands of the printer March 4, 1879.

E. W. B.

The ordinates of a simple harmonic represent the movements impressed on the aërial molecules during the transmission of a *pure* musical tone. In general, however, musical sounds consist of a "fundamental" accompanied by "harmonics" or "overtones," and hence the movements will be represented by a compound harmonic curve of greater or less complexity. This will also be the case when two or more musical sounds of different "pitch," "quality," or intensity simultaneously affect the air. The curve also shows the variations of pressure on the *membrana tympani* as the sounds enter the ear, and its construction would, therefore, seem to be a necessary condition for a complete investigation of the physiology of Hearing.

The study of these curves offers us two problems of almost equal importance and interest, viz.: First, Given the curve; required, to find its component simple elements. Second, Given the component simple curves; required to construct the resulting compound curve. From the standpoint of Acoustics these problems may be stated thus: First, Given a complex sound, required to find the simple musical tones of which it is composed. Second, Given the intensity, pitch, and phase of each of a number of pure musical tones; required, to find the effect of their simultaneous action on the air.

The problem of analyzing a complex sound is, to a certain extent, solved by the ear with wonderful ease and accuracy, especially when trained, and our perception of differences in the quality of sounds depends on our recognition of the variation of the harmonic elements entering into the sounds compared. This analysis is, however, rather a perception of differences than a definite recognition of the particular components and the laborious investigations of Donders, Helmholtz, and others into the constitution of the simplest elements of speech—the vowel sounds—show that the actual analysis of the simplest articulate sound is no easy matter. When the curve corresponding to the sound is once obtained, Fourier's theorem enables us to subject it to mathematical analysis, and thus determine, by a somewhat laborious process, its simple harmonic elements. Three methods give us such curves. König[1] employed two tuning-forks to actually draw the curve belonging to their combination; this method is limited to combination of two simple tones. Messrs. Jenkin and Ewing[1] magnified the impression made on the tin-foil of the *phonograph*, obtaining thus the curve belonging to the sound impressed on the vibrating disc. Their results are of the highest interest, and mark an advance in the analysis of vocal sounds, but the articulation of the phonograph is not perfect and its quality is so different from ordinary—not to say agreeable human speech, that its complete analysis would still leave our knowledge of the actual constituents of articulate sounds in a defective state.

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[1] Poggendorff's Annalen, Bd. CLVII., S. 177.—1876.

A third method[2] is the photographing of the vibrations of a disc set in vibration by the sound to be analyzed. The curves are drawn with great sharpness and seem to offer the best means for pursuing this investigation. It was the study of these photographs which led me to consult with Prof. H. A. Newton, of Yale College, on the possibility of producing similar curves by mechanical means. Prof. Donkin, F.R.S., had described a machine by which the combination of any *two* simple tones could be drawn,[3] but the apparatus was not available for more complex combinations. The machine now to be described was the result of this consultation, and I take pleasure in ascribing its success to the valuable suggestions given me by Prof. Newton.

Plate I. represents the machine. A, A^{I}, A^{II}, A^{III}, A^{IV}, A^{V}, are T-shaped pieces of sheet brass, sliding between screws, motion being given to each by a crank-pin entering a slot cut in the cross-bar of the T. Each crank is driven by a pulley which is set in revolution by a string passing completely around it. The crank-arms are adjustable in length, being clamped in the desired position by screws. The pulleys are easily changeable, being fitted on square tapering portions of the axles, where they hold by friction, and are readily dislodged when necessary. The same string runs around each and all the pulleys, so that all turn simultaneously. The wheel B serves to return the string to the tightening pulley D, which gives or takes up the "slack" when the crank-pulleys are changed.

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[1] Nature. May 9, 1878; July 25, 1878.

[2] Silliman's American Journal, Vol. XVI., 3d Series, July, 1878. Nature, July 25, 1878.

[3] Royal Society Proceedings, XXII., p. 196. British Association Reports, 1873. XLIII., p. 65.

Firmly attached to B, and revolving on the same axle, is a smaller wheel which drives the roller feeding the paper on which the curves are traced. To secure the necessary tightening of the second string, the axle of B is inserted in the end of a wooden bar which slides horizontally under the frame. The strain given by D having tightened the string sufficiently, this bar is clamped by the thumb-nut, F.

The driving roller, G, is covered with sand-paper, and the pressure of the companion roller, H, secures the feed of the paper between them. A small brass wheel, C, is pressed by the spring of its steel axle on the middle of the paper strip. It has a sharp edge, and prevents lateral motion of the paper liable to result from friction of the pencils.

E, E^{i}, E^{ii}, are strips of brass sliding between screws. Each has a steel spring attached to it, to the end of which a thick piece of brass is soldered. A hole through this brass is tapped with a screw thread, into which the pencils (or tubular pens) fit and are readily adjusted to the desired height. E, E^{i}, and E^{ii}, have each a steel pin projecting upward from their middle points. Similar pins project from points near the ends of A, A^{i}, A^{ii}, etc.

A cross-bar connects the pins A^{i}, E^{ii}, and A^{ii}, the joint at E^{ii} admitting simply of revolution, while at A^{i} and A^{ii}, there are slots in the bar permitting both rotation and sliding. A^{iii}, A^{iv}, and E, are similarly connected. A third cross-bar connects E and E^{ii} with E^{i}, having slots at E and E^{ii}, and a simple rotary joint at E^{i}.

A is not represented as in action, in order not to complicate the drawing and description unnecessarily. It would be connected by a cross-bar with E^{i}, and a fourth slider (E^{iii}) placed midway between A and E^{i}.

The operation is as follows: Imagine a strip of paper fed between the rollers and passing under the pencils. The pulleys revolve by the action of the string, and their cranks give the respective T's movements which are the rectilinear components of the circular movements of the crank-pins. A pencil attached *directly* to any one of the T's, would therefore draw on the paper a simple harmonic curve,[1] whose "period" depends on the diameter of the pulley, and whose amplitude depends on the length of the crank-arm. The connection of the cross-bars with E and E^{11}, compels these strips to perform movements which are respectively *one-half* those of A^{1v} + A^{111}, and A^{11} + A^{1}. Hence, from the pencil in E, we get a curve combining A^{1v} and A^{111}, but having ordinates of one-half their sum; from the pencil in E^{11}, a curve combining A^{11} and A^{1}, in like manner. Finally, the cross-bar connecting E and E^{11} determines a movement of E^{1} which is *one-fourth* the sum of the movements of the four T's, and, therefore, E^{1} describes upon the paper the curve belonging to the chosen relations of "period," "amplitude," and "phase."

The relations of these three terms may be varied to any extent (within practical limits), and with great ease. The accuracy with which a definite period may be obtained without the use of gearing, is quite surprising.

It is evident that gearing might be substituted for the pulleys, but the increased complication, friction, and difficulty of adjusting changes, would hardly compensate for the increased definiteness of period thus attained.

The apparatus has a wide range of applications in the study of periodic curves, the discussion of which does not come within the province of this journal.

Specimens of the curves obtained are given in Plate 2.

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[1] **This method of drawing simple harmonic curves is due to Prof. E. C. Pickering. See Journal Franklin Institute, Vol. LVII., p. 55.**

SPECIMENS OF THE CURVES DRAWN BY THE MACHINE ARE GIVEN IN PLATE 2.

Nos. 1 to 8 (inclusive) are combinations of the first four terms of the Harmonic Series:

Ratios of Vibration...................... 1 : 2 : 3 : 4.
Amplitudes of Vibration .... 1 $\frac{1}{2}$ $\frac{1}{3}$ $\frac{1}{4}$.
No. 1. All four tones in the same phase when starting.
“ 2. Tone 1 advanced $\frac{1}{4}$ vibration when starting.
“ 3. “ 2 “ “ “ “
“ 4. “ 3 “ “ “ “
“ 5. “ 4 “ “ “ “
“ 5*a*. “ 1 “ $\frac{1}{8}$ “ “
“ 6. “ 2 “ “ “ “
“ 7. “ 3 “ “ “ “
“ 8. “ 4 “ “ “ “

Nos. 9 to 18 (inclusive) are combinations of the first three *odd* terms of the Harmonic Series:

Ratios of Vibration...................... 1 : 3 : 5.
Amplitudes of Vibration .... 1 $\frac{1}{3}$ $\frac{1}{5}$.
No. 9. All three tones in the same phase when starting.
“ 10. Tone 1 advanced $\frac{1}{8}$ vibration when starting.
“ 11. “ “ “ $\frac{1}{4}$ “ “
“ 12. “ “ “ $\frac{3}{8}$ “ “
“ 13. “ 3 “ $\frac{1}{8}$ “ “
“ 14. “ “ “ $\frac{1}{4}$ “ “
“ 15. “ “ “ $\frac{3}{8}$ “ “
“ 16. “ 5 “ $\frac{1}{8}$ “ “
“ 17. “ “ “ $\frac{1}{4}$ “ “
“ 18. “ “ “ $\frac{3}{8}$ “ “

Nos. 19 and 20 are combinations from the Diatonic Scale. No. 19 shows the Common Chord, *Major:*

Ratios of Vibration...................... 1 : $\frac{5}{4}$: $\frac{3}{2}$.

No. 20 shows the Common Chord, *Minor:*

Ratios of Vibration...................... 1 : $\frac{6}{5}$: $\frac{3}{2}$.

In both the intensities of the component tones are equal, and their phases at starting identical.

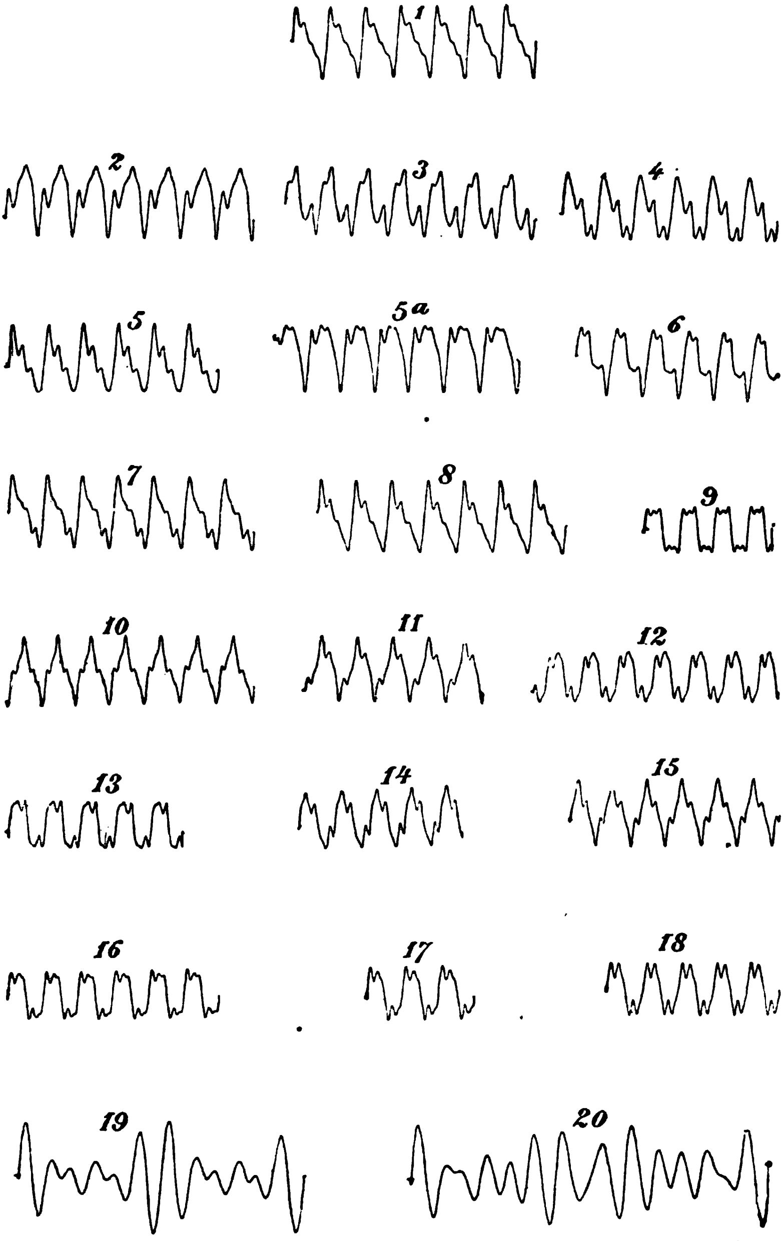

Plate 2.

PHOTO-ELECTRO-CO., BOSTON.

PROPOSED METHODS OF MEASURING THE RELATIVE INTENSITIES OF THE SENSATIONS OF SOUND.

By ALFRED M. MAYER.

To obtain measures of the intensities of sonorous sensations, so that the otologist may trace the changes in the audition of his patient with his treatment, I propose the following plans:

A closed organ-pipe (say c', of 512 v. per sec.) of metal, with the parts of its embouchure of fixed and definite dimensions, is mounted on a rod, away from reflecting surfaces, and is blown with air of a constant and definite pressure. Opposite the mouth of the pipe is a resonator accurately tuned to the pipe. This resonator slides along a horizontal scale, so that the distance of the plane of its mouth from the plane of the mouth of the organ-pipe can be readily measured. A tube leads from the nipple of the resonator to a distant room, where the patient's ear is to be tested.

From experiments on normal ears it can be decided at what distance of the resonator from the pipe the sound of the latter is generally inaudible. This distance we will call the unit distance.

The patient's ear will then be tabulated, in its appreciation of sound, in fraction of this unit distance; or, better, in fractions of intensity, by stating the condition of his ear in terms of the *square* of the fraction of the unit distance at which he just ceases to perceive the sound of the pipe. Thus, if the patient loses the sonorous sensation at $\frac{1}{2}$, $\frac{1}{3}$, or $\frac{1}{4}$ of the unit distance, his hearing is tabulated respectively as $\frac{1}{4}$, $\frac{1}{9}$, or $\frac{1}{16}$ of the normal perception.

The pitch of the pipe, the material out of which it shall be constructed, the dimensions of the parts of its embouchure, its length, diameter, form, and the pressure, in inches of water, of the blast of air which sounds it, can be determined upon by a congress of otologists, so that their observations will be comparable everywhere.

The tube leading from the resonator to the ear of the patient need not be all of rubber; its terminals may be constructed of this substance, while its intermediate portion may be of tin tubing.

For the successful practice of this method it is necessary that the room in which the sound is generated should not have reflecting walls and floor, and should be devoid of resonance. To obtain this condition is only a matter of expense; a small room whose floor and walls are covered with rubber cloth, or felt saturated with some fluid, like glycerine, will give them.

I have experimented with the apparatus just described, and will await the decision of otologists as to its value to them. I have found a c′ (512 v. per sec.) pipe to be of a convenient and natural pitch.

Experiments have also been made with a similar apparatus, in which the resonator and conducting tube were replaced by a telephone held near the pipe and connected by wires to another telephone placed close to the ear. I have found that sounds about the pitch of c′ (256 complete vibrations per sec.) had a very slight effect on the plates of the telephones used by me. A c′ closed organ-pipe worked well, its unit distance being at about 12 ins. With the highly composite sound given by the stump of a reed trumpet organ-pipe of about the pitch of c′, the unit distance was 18 inches.

There are reasons to be of the opinion that the intensity of the sensation of sound varies as the logarithm of the mechanical energy of vibrations causing it, but we need not (at least in the present crude condition of the problem we are attempting to solve) bring this refinement into our discussion.

The sound used in these experiments should not be continuous, but intermittent.

THE GRAPHIC AND PHOTOGRAPHIC ILLUSTRATION OF SOUND-WAVES.

By CLARENCE J. BLAKE, M.D., Boston.

II.

A comparison of the two methods of obtaining permanent records of sound waves would seem to be much in favor of the method employing photography for the accomplishment of this purpose for the reasons given in the first part of this paper. The photographic method presents certain mechanical difficulties by no means insurmountable in the accurate adjustment of an apparatus in which the reflecting surface must be arranged to respond justly to the vibrations of the disc or membrane tested, and in which the recording surface must move uniformly at a high rate of speed.

By varying the accelerating weight, in the apparatus of Prof. Blake, and its fall, any manageable velocity may be given to the carriage. In obtaining records of speech, as each syllable requires for its articulation about one-fourth of a second, the velocity must be great and the recording plates correspondingly long. Prof. Blake employed plates about two feet in length and obtained good results with velocities of from sixteen to forty inches per second. The action of the light, however, is inversely as the velocity, and to compensate for this the size of the circular opening admitting the light to the vibrating mirror should be increased. This, of course, causes an enlargement of the luminous image, and appar-

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Note.—In the first paper mention was omitted of the first vibrograph of Thomas Young, M.D., who describes, in the first volume of his Lectures on Natural Philosophy, (New Edition, edited by Rev. P. Kelland, M.A., F.R.S., p. 147. London, 1845), "an instrument by means of which we may measure, without difficulty, the frequency of the vibrations of sounding bodies, by connecting them with a point which will describe an undulated path on the roller."

ently involves an injurious widening of the line traced; but, as observed by Dr. Stein, in his experiments, the effect of velocity is to narrow the line photographed, since the maximum exposure is in that diameter of the circular image which lies in the line of motion. This is a great advantage, since a variation of velocity in the vibration is marked by the widening of the line, often more clearly than by the form of the curve.[1]

The application of this method to obtaining records of the vibrations of the human membrana tympani possesses obvious advantages—an important consideration, since the membrana tympani and ossicula form the most perfect apparatus for the mechanical transmission of sonorous vibrations of which we have any knowledge, and even with the imperfections which necessarily result in the process of its preparation for phonautographic use, it far surpasses for this purpose any artificially constructed membrane.

In studying the vibrations of so delicate a mechanism it is absolutely necessary to avoid, as far as possible, the introduction of any disturbing element, and to obtain the transference of the movement to the recording surface with as little interference as possible. The chief difficulty lies in the mechanical adjustment of the mirror, the excursions of the membrana tympani and ossicula in response to articulate speech being so slight[2] as to render it necessary to use a mirror of the slightest weight and with a most delicate adjustment. That the general mechanism of the apparatus would require proportionate modifications is also evident.

In concluding the communication above quoted, Prof. Blake says: "Are all the audible elements of speech traceable in these records—in other words, is the record complete? I am not prepared as yet to answer this question definitely, but the following experiment leads me to doubt whether an affirmative answer can be given, while at the same time it illustrates in a striking manner the sensitiveness of the ear. The mirror was attached to the disc of a receiving telephone, and a photograph taken from it while the instrument was talking audibly. The resulting record was almost a smooth line, showing but very slight indications of the movement of the mirror. It would, therefore, appear that there are distinctly audible elements, which are too minute to be recorded by this method. It is to be noted, however, that the width of the line traced, where the vibrations are extremely small, is so great as to mask the curvature so that the experiment just cited is not entirely fair."

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[1] **Extract from "A Method of Recording Articulate Vibrations by Means of Photography." E. W. Blake, Jr., Am. Jour. Science and Arts, July, 1878.**

[2] **Compare C. H. Burnett. An investigation concerning the mechanism of the ossicles of hearing, and the membrane of the round window.**

That this result should have been obtained in photographing the vibrations of the *receiving* telephone disc as compared with the photographs of the vibrations of the disc of the transmitting telephone is illustrated by comparisons of the measurements of the excursion of the discs of the transmitting and receiving telephone in response to a vowel sound of 448 vibrations in the second, as made by the writer. In these experiments the excursion of the transmitting telephone disc, without the magnet, was first recorded, the average of all the readings for the vowel sound a, 448 v. s., measured under the microscope, with micrometer eye-piece, being 0.2625 millimetre. The magnet being readjusted, the deflection of the centre of the disc due to magnetic attraction was found to be 0.061 millimetre. As would be expected, a deflection of the plate to this extent would produce a very appreciable difference in its excursion, and the average of a large number of measurements of the movement of the disc of the transmitting telephone under traction of the magnet gave the length of the excursion as 0.19 millimetre, while the average of corresponding measurements of the movement of the receiving telephone gave the length of the excursion as 0.0135 millimetre—a difference in motion between the two telephone discs of 92.9 per cent.[1]

The recording by photography of the distinctly audible elements of speech, represented in the experiment cited only by a widening of the line upon the sensitive plate, must come as the result of further experiments in perfecting the apparatus employed; as it is, the record may be taken as representing much more accurately the vibrations of the metallic telephone disc than any record made by the graphic method. In the "phonograph" record, for instance, the marks impressed by the phonograph, according to Auerbach, contain certain peculiarities which, although without influence on the tones spoken from the instrument, remain effective in modifying the curves obtained by mechanically transferring them.[1] The peculiar value of the phonograph for experimental purposes, already alluded to, in the audible reproduction of the sound traced upon the foil is somewhat modified by the unreliability of the ear as a means of making an accurate test, and the mere fact that the spoken word, as modified by the vibration of the metallic disc, is apparently perfectly reproduced does not justify the supposition that all the audible elements of the speech have been transcribed, while the value, for purposes of investigation, of the mechanically transferred record is lessened for the reason above given.

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[1] **C. J. Blake: "Sound in Relation to the Telephone," read before the British Society of Telegraph Engineers, London, May 8, 1878.**

The defects of the other methods of graphic record, already alluded to, which greatly impair their value for purposes of study, is further illustrated by the modifying effect of purely accidental causes, in the weighting and adjustment of the vibrating membrane and stylus for instance, and in the unavoidable variations in the character of the recording surface.

Comparative objections pertain, but in a much less degree, in the photographic method. These can be overcome in a measure, but only as the result of persistent and careful experiment. With such improvements the photographic method will undoubtedly become the best means for obtaining a permanent record for the accurate illustration of sound waves.

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[1] **F. Auerbach. "The Phonograph and Vowel Sounds."—Note. "Nature," Dec. 12, 1878.**

TWENTY CASES OF THE GROWTH OF ASPERGILLUS IN THE LIVING HUMAN EAR.

By CHARLES HENRY BURNETT, M.D.,

PHILADELPHIA, PA.

(Continued from the January number.)

Case VII.—*Aspergillus nigricans in the right auditory canal.*—Mr. B. F. J., of St. Louis, Mo., came under observation October 13, 1876, with a letter of introduction from Dr. H. N. Spencer.

The patient, a clerk, was forty years old, and had suffered many years with chronic discharge from both ears. He had at last applied to Dr. Spencer, who had found aspergillus in the ear, but had succeeded in removing it, allaying the discharges to a great degree and improving the hearing greatly.

Upon examination, I found that the left ear was not discharging, and that the auditory canal on that side was filled with hardened crusts of purulent matter and epithelial débris.

On the right side, however, the patient complained of discomfort, fulness, burning, and a slight watery discharge, in fact a renewal of the symptoms, which had been relieved for him by his physician at home. On inspection, the membrana tympani was found covered by a delicate false membrane of aspergillus.

Treatment.—The treatment consisted in instillations of absolute alcohol, three times daily, the dose being from ten to fifteen drops each time. Though the ear became better, the patient passed from observation before I was satisfied that the ear was entirely free from aspergillus.

Case VIII.—*Aspergillus nigricans in the right auditory canal.*—The patient in this instance, a lad of fifteen years, from Georgia, was the youngest person in whose ear I have found the aspergillus.

This case came under observation, October 28, 1876, for hardness of hearing. The lad stated that during the previous summer his ear had throbbed and itched, for which the syringe was used, with some relief. Since then the ear had felt more or less stopped up.

On inspection, an obstructive mass was seen in the canal, which, on being washed out by means of the syringe, I found to consist chiefly of aspergillus in all stages of development, preserved as it were in a cyst of cerumen.

The *treatment* consisted in the use of alcohol instillation for a few days, and there was no return of the fungus.

This case, aside from the youth of the patient, presented a curious example of the presence of aspergillus in the ear, without the characteristic symptoms of heat, sticking pain, and watery discharge, for it seems probable that the fungus had been in the canal for some time, as the removed mass was covered over with wax and dead skin. I have observed that the aspergillus will not flourish in the presence of cerumen, *i. e.*, not to an extent sufficient to inflame the ear, and thus its long and harmless presence in the ear may be accounted for in this instance. This fact of the protective value of cerumen is further shown in those cases where the cerumen has been scraped from the ear, through a mistaken idea of personal cleanliness. In such cases, aspergillus is almost sure to spring up, and, on inquiry, there will be elicited the fact that the ear has been scratched, either with pins, hairpins, ear-picks, or some other equally pernicious implement, for the purpose of "cleaning the ear."

CASE IX.—*Aspergillus nigricans in both auditory canals.*—The patient, H. B., aged seventeen years, does not live in the best hygienic way. He has been annoyed for some time with an eczematous condition of both ears. On November 14, 1876, he presented himself for treatment at the Philadelphia Infirmary for Diseases of the Ear. Both auditory canals were found plugged with a mass of whitish and tenacious layers, and this, on microscopic examination, was found to be chiefly composed of aspergillus in all stages of development. There was some itching in the ears, from which a watery discharge came.

Treatment.—Alcohol being used, in a short time all signs of the aspergillus disappeared.

In this case I believe the eczema preceded the growth of aspergillus, the latter being fostered by the use of various unguents for the cure of the former. The ointments collecting in the ear, with portions of dead animal matter from the aural discharges, formed a rancid and putrefying soil for the parasitic saprophyte.

CASE X.—*Aspergillus nigricans in the left auditory canal.*—Mr. J. N. B., of Philadelphia, aged forty years, living in the best of hygienic circumstances, came under observation March 29, 1877, for what he supposed was eczema of the left ear. Mr. B. stated that he has been liable to attacks of eczema throughout the body, for several years. Within a month he had had itching, pain, and

sense of fulness, in the left ear, with a slight watery discharge. He had also pulled blackish scales from the ear, and at times he had had small furunculi near the meatus.

Inspection, by means of the aural mirror, revealed the membrana tympani to be covered with a fungous membrane or pellicle, under which the dermoid layer of the drum-head was macerated and reddened. The microscope revealed the presence of the aspergillus in a flourishing condition. There was unmistakable eczema of the meatus and outer part of the auditory canal.

***Treatment.*—The treatment consisted in the application of benzoated oxide of zinc ointment, by means of a camel's-hair brush, to the eczematous spots, and alcohol instillations were employed to destroy the fungus.**

The undiluted alcohol proved too painful, as the skin was much broken by the eczema, but by diluting the alcohol with an equal amount of water, I was able to obtain the benefits of its application without the smarting and irritation. By carefully watching the ear for any signs of renewal of the growth, and the continued use of the dilute alcohol instillations for ten days, the canal healed, the lustre returned to the membrana tympani, and the patient passed from treatment.

In this case, also, as in the previous one, eczema probably preceded and invited the aspergillus.

CASE XI.—*Aspergillus nigricans in the left auditory canal.*—The patient, a wine merchant of Philadelphia, sixty-seven years old, came under observation May 3, 1877, for hardness of hearing, supposed to be due to hardened cerumen. He was strong and well, and lived in comfort and good hygienic surroundings. He had felt, some weeks before I saw him, a buzzing in his left ear, attended with a slight diminution of hearing and an itching pain. A very slight watery discharge had run from his ear at times since these symptoms were first noticed, and his physician had syringed the ear several times, washing out each time a substance said to be cerumen.

Upon inspection of the ear there was detected, deep in the anterior part of the auditory canal, near the membrana tympani, in the angle formed by the latter and the anterior wall of the canal, a dirty-white mass, looking somewhat like moist newspaper. By examination with the microscope its true nature was shown to be aspergillus, in the form of a false membrane adherent to, and partially covering the anterior half of the membrana tympani.

***Treatment.*—I was able to seize this mass and lift it entirely from the membrana tympani, without pain to the patient. Beneath this mass the fundus of the auditory canal and that part of the membrana tympani covered by the fungus, was red and inflamed, but the free portion of the drum-head was normal in color. Alcohol was then instilled.**

The next day a fresh patch of the fungus had grown in its former seat, and

this I again removed with forceps. The alcohol instillations in this case caused some discomfort from the burning sensation in the ear. The patient then used, for a day or two, dilute alcohol at home and syringing with tepid water, under which treatment, by the 5th of May, the membrana tympani was found entirely free from the fungus, the hearing was good and there was no more tinnitus aurium.

On June 18th there was a slight return of the fungus, but under the resumption of the alcohol and the syringing, all symptoms vanished, and the ear remained free.

At the time of the relapse there were some furuncles in the auditory canal.

This man was the oldest person in whose ear I have found the aspergillus, and the case is further of interest from the pertinacity of the growth of the fungus. It never obtained great headway, but it reappeared in the same spot several times while under my observation, and probably, from the history of the case, had reappeared several times while under the care of his family physician. It only shows that such cases must be carefully watched, and every fresh outcrop of the fungus removed until no trace of the parasite is to be found in the ear. If this is not done, a chronic and stubborn aural disease may be established.

Case XII.—*Aspergillus nigricans in the left auditory canal.*—Adam Smith, thirty-eight years old, a wool carder, came to the Philadelphia Infirmary for Diseases of the Ear, September 21, 1877. His statement was that for some time he had been hard of hearing in the left ear; that the ear felt stopped up, and that a slight watery discharge came from it.

On inspection the auditory canal was found to be entirely filled from drum-head to the meatus with a soft, whitish plug of what finally was shown to be a mass of aspergillus in all stages of growth. This ear became very much inflamed, and the aspergillus grew with great pertinacity for some weeks. Alcohol was too painful to the ear in its inflamed state, and syringing with warm water was relied upon alone.

Perhaps this man's business, which exposed him to dampness and a constant surrounding of damp wool, impregnated with dead animal matter, favored the development and growth of the fungus. Be this as it may, this case was the first in which I had found aspergillus in an individual living in a decidedly unclean and poor way. And yet the general theory has been that this aural disease is found chiefly if not entirely, in the poor and squalid.

CASE XIII.—*Aspergillus nigricans in both auditory canals.*—(A.) Mr. W. W. J., aged sixty-two, a lawyer, living in the best of hygienic surroundings, came under observation September 27, 1877.

The statement of the patient was that during the summer, while at Atlantic City, *where he did not bathe*, he was affected with hardness of hearing rather suddenly, and for the first time in his life. Upon consulting a physician in the summer resort it was thought that the auditory canals were plugged with wax, and the ears were syringed upon several occasions by means of a fountain syringe. This brought away each time some plugs supposed to be of cerumen, but the ears did not become comfortable nor did the hearing become normal; the latter was muffled and there was some tinnitus, with slight and fleeting pains in the ear. There was no history of a discharge from the ears.

On inspection I found both canals plugged with a suspicious looking mass, most evidently not cerumen. After syringing this out, each membrana tympani was found congested at the periphery and malleus, and the general surface was roughened and irritated in appearance to an extent not to be accounted for by the small amount of syringing I had used to cleanse the canals. There were no adherent patches of fungus, nor consequently any false membrane in either ear. The patient was not advised to pursue any treatment at home, but was asked to call in three days. Before this time elapsed the patient presented himself, on a Sunday morning, on account of the itching and discomfort in his ears.

It was found that the canals, which on Friday previous were dry, though a little scaly in appearance, but not congested, had become covered with a false membrane, which extended to and over the membrana tympani. This I removed by syringing with alcohol and water, one part to four, and by a little aid from delicate forceps. The membrana tympani on each side had assumed the thickened, reddened, and irritated appearance characteristic of *myringomycosis aspergillina.*

Portions of the false membrane thus removed, on being examined by the microscope, showed the various parts of the flourishing aspergillus.

The patient was seen the next day, when it was found that the false membrane had formed again, and the ears looked as they did the day before. The canals and membranæ tympani were again cleared and the patient ordered to syringe the ears at home and to instil thrice daily ten to fifteen drops of a solution of hyposulphite of soda in water, 3 gr. to f ℥ i.

This controlled the disease by checking the further growth of the fungus; the patient was seen every day until a week had elapsed, when no more fungus having appeared the case was dismissed, with the hearing perfect and the ears comfortable.

B. *September* 2, 1878.—A curious instance of a return of this fungus to an ear previously attacked by it was noted in this patient. The liability of return to an ear once invaded by the aspergillus has been noted by others, but the length of the interval between the attacks has not been given. In this case it was almost exactly one year.

The patient gave an account of an onset of dulness of hearing on the left side during the summer at Atlantic City, somewhat similar to that of the previous year.

There had been slight pain in both ears, with a sense of discomfort and fulness, but no discharge.

Upon examination there was found quite a large plug of epithelium and aspergillus in the left ear and a small mass of the same in the right ear.

The left ear was more tender and swollen than the right. The canals were syringed with alcohol and water, but at home the patient was not ordered to use any application to the ears, since I had resolved to make all the necessary applications myself, having come to the conclusion that patients with aspergillus in the ear are apt to irritate their ears by treating themselves and thus favor the continued growth of the fungus. At most I order alcohol drops, if the ear itches greatly, to be used in the intervals between the visits to me; but no syringing. Of course I expect to see the case every day.

In the course of four days I found some false membrane of aspergillus in the left ear, but none in the right; the left ear was still painful and swollen. I applied alcohol and water, equal parts, and saw the patient the next day.

I again found some patches of aspergillus, but the ear was much less tender and swollen. The hearing was dull still. After removal of the patches of aspergillus the ear was syringed with alcohol and water, and from this time there was no return of the fungus in the ears.

It was found that this patient had been in the habit of using large quantities of soap-suds in the concha and in the meatus, with the idea of great cleanliness. This undue washing accounts for the growth of the fungus, as I think can be shown by reflecting that this manipulation would wash away the cerumen, the natural protector of the auditory canal. The skin would thus become irritated and a deposition of aspergillus-spores taking place, on this fitting soil, the fungus would gain lodgment in the ears. With its well-known tendency to seclusion, the parasite seeks, and soon spreads over, the bottom of the auditory canal and the drum-head, and thus can be explained the origin of the disease in this case as well as in numerous others.

CASE XIV.—*Aspergillus nigricans in the left auditory canal.*—Mr. R. S., aged 42, of Philadelphia; a watchman in a bonded warehouse, came to the Infirmary for Diseases of the Ear, November 15, 1877, complaining of earache, discharge from the ear, and hardness of hearing.

The patient thinks he caught cold from necessary exposure at night, in his duties as watchman. His general health is very good, his frame large and powerful, and his complexion very ruddy; he gets good wages and lives well.

On inspection, the membrana tympani was found perforated at the middle of the posterior half, and from the opening a mucous discharge of slight amount was observed to flow. Over the membrana tympani and about the perforation in it, there was seen a whitish, felt-like membrane, which was shown by the microscope to be composed of the aspergillus in flourishing condition.

I am disposed to think that the aspergillus had invaded this ear subsequently to a slight catarrhal inflammation of the drum-cavity, attended with perforation of the membrana tympani. The ear was not attended to for some days, and the slight mucous discharge, being allowed to remain in the ear, supplied the necessary soil for the fungus, and this, by gaining root on the diseased drum-head, set up irritation and pain, which at last brought him to the Infirmary for relief. This case, like most others seen in Infirmaries, disappeared before the treatment was completed, and a satisfactory condition established in the ear. But, it serves as an example of the readiness with which the aspergillus springs up in an ear which has been the seat of inflammation, and in which a small quantity of the results of inflammation is allowed to remain and decompose.

CASE XV.—*Aspergillus nigricans in the left auditory canal.*—A. Miss Kate T., aged 24 years, a seamstress, was first seen in the Philadelphia Infirmary for Diseases of the Ear, September 26, 1877. She states that in the early part of the previous summer, without any warning, her left ear began to discharge a scanty, but offensive matter. As she was in the country at the time, nothing was done for the ear, until she came under treatment in the Infirmary.

On inspection of the ear, by means of the aural mirror and speculum, a polypus was seen seated over the position of the membrana flaccida, below which the lower part of the membrana tympani proper was seen to be intact, though macerated by the discharge which flowed from the region of the polypus. On examination by means of the probe, it was found that the polypus occupied the place of the membrana flaccida.

Treatment.—Part of the polypus was taken away at the first visit by means of Blakes-Wilde's snare and the remnant cauterized by means of chromic acid. The chromic acid was conveyed to the remnant of the polyp by means of cotton on the cotton-holder, by wrapping the end of the latter with cotton rolled tightly about it, until the end of the holder was about as large as a good-sized grain of shot. Then, with this cotton-bulb, a small crystal of chromic acid is crushed into a kind of paste, which adhering only to the end of the tuft, is conveyed to the diseased spot. Of course it is understood that only those prepared to skilfully treat diseases of the ear must undertake to perform this or any other delicate local treatment of disease of the ear. Not only knowledge of the parts and *their relation to each other* must be understood, but the art of conveying medication to the diseased organs, under full illumination of the auditory canal, by means of the forehead mirror, must have been mastered.

I consider this digression upon the subject of the art of treating locally aural diseases as necessary alike for the aurist's indemnification and for the patient's welfare.

On the 27th September, the next day, I removed a slough from the remnant of the polyp and applied more chromic acid. The discharge from the ear had become much less. On the following day I removed still more slough, and exposed to view all of the membrana tympani, below the folds. It was now seen that the polypus sprang, by a broad attachment, from the entire surface of the spot occupied by that part of the drum-head known as Shrapnell's membrane, or the membrana flaccida. The cut surface of the attachment now amounted to an ulceration of the above-named territory.

Between this time and the 1st October following, two more applications of the chromic acid were made, and by the end of a week the ulcerated surface was on a level with the rest of the membrana tympani. At home the patient used a 2 gr. solution of sulphate of zinc in water, and syringing. The discharge, by the 3d of October, was reduced to a minimum. The ulcerated surface was now touched with a saturated solution of nitrate of silver (480 gr. to f. ℥ i. of water), conveyed to it in the same manner as the chromic acid, alluded to above.

The conveyance of nitrate of silver, by means of a button or tuft of absorbent cotton, twisted tightly about a cotton-holder, has seemed to me to be equivalent to the use of a button of the solid stick, fused to a probe. It is surely a more convenient way, and I dare say a safer one, for I never saw a button of nitrate of silver fused to a metal stem that was not brittle, and hence liable to come off either at a time or in a quantity not to be desired.

Two days later the ear was examined and it was seen that a slight discharge bathed the ulcerated spot, and that the membrana tympani was congested about the malleus. The zinc drops were continued and the ear was syringed, but beyond this no local treatment was carried out.

The next day, October 6, there was a slight soreness of the meatus, which I felt was due to the excessive manipulation the ear necessarily had been subjected to. I, therefore, blew into the canal, and over the membrana tympani, a little drying powder, composed of one part of salicylic acid to two of magnesia (Chisholm), and told the patient to leave the ear alone.

Four days thereafter I saw the patient, and there was a necrotic spot in the place of the short process of the malleus. The discharge had ceased, but I again insufflated the above-named powder, and then ordered the ear to be let alone.

The next day the ear felt comfortable; the ulceration appeared to be healing, though still smeared with a little creamy pus. This was dried off by absorbent cotton. There was no odor, but the black, rough, necrotic spot over the short process remained unchanged. The treatment consisted in *my* keeping the ear clean, the patient *doing nothing at home.*

By the 17th October, my note-book states, there was no change in the black spot over the short process, and there was scarcely a trace of discharge. The dry treatment was then kept up for two days longer, when the ear ceased to discharge. It may be said that now the ear had passed into another condition. The hearing was not much improved, but all pain, soreness, and discharge had ceased, and it was seen that the membrana flaccida had healed, but not with a normal appearance, as it was sunken and irregular in surface. At no time was there detected a perforation into the tympanic cavity, from the ulcerated surface. There was still the black spot of necrosis, which sat like a cap over the short process. This, of course, I felt would be fertile soil for the aspergillus, and I therefore not only watched it closely day by day, but applied, October 19th, glycerine and salicylic acid (gr. xvi. to f. ℥ i.) to the diseased spot, by means of cotton on the cotton-holder.

The patient, now considering herself well, and also finding it inconvenient to come to me, absented herself for exactly one month.

On the 19th of November, the necrotic spot over short process was found *unchanged;* there was marked irritation of the membrana tympani and of the fundus of the auditory canal, and a slight dark-colored discharge smeared the seat of the old ulcer, and the membrana tympani. The ear was then cleansed of this discharge, which proved to be very offensive and irritating, and the necrotic spot was again touched with the above-named mixture of glycerine and salicylic acid. It seemed that this offensive discharge came from the necrotic spot, not from the old ulcer, in the membrana flaccida. In the course of two days *a fine yellow, pollen- or felt-like substance,* was found around the walls of the auditory canal, near the membrana tympani. This *proved to be* the early stages of a growth of aspergillus.

The ear was thoroughly syringed with alcohol and water, and all traces of the fungus were thus removed as far as possible. The ulceration at the membrana flaccida was apparently breaking out again.

Two days subsequent to this, the ear was again seen and a mycelial membrane was found over the upper part of the drum-head; the necrosis of the short process was no better—perhaps extending a little; the membrana tympani at its upper part was raw beneath the fungous web, while its lower part remained unattacked. The patient complained of *beating in the ear.* Three days later, November 26th, a large piece of the mycelial web, one-quarter inch square, was washed from the ear. Since the last visit, the patient had used alcohol instillations and syringing, and this may account for the rapid detachment of large pieces of the fungous mass. The necrosed spot on the short process seemed to be moving, *i. e.*, growing off and leaving a clean short process beneath. The necrosis seemed to have ceased.

The ear was watched closely again, and the use of alcohol washes and the syringe kept up, several times daily, for two days longer.

Two days later, there was no trace of aspergillus, and *the eschar on the short process was seen to be decidedly growing forward and off, what now began to look like a normal short process.*

This black spot continued to narrow, and a scaly coat of epithelium formed around and over it. In the course of a month this rough coat of epithelium had covered the eschar, or rather the site of the eschar, and had moved upward and away from the short process, leaving the latter perfectly normal, and had covered the ulceration in the membrana flaccida. The ear then became entirely dry and comfortable to the patient, though the hearing was not much improved.

B. On April 4, 1878, a little over three months from her last visit to me, the patient presented herself again, with the statement that for two weeks she had felt pain and soreness in the left ear, and that three days before her call on me, she had noticed a watery discharge from the ear, since which the pain and burning had ceased.

Treatment.—On inspection, the concha was found red and tender, and the canal swollen. In the latter, at the fundus and over the old ulceration, there was found some deposit of aspergillus, which was removed and the ear syringed with alcohol and water, and the patient told to instil alcohol and water at home, but not to syringe. By omitting the use of the syringe while instilling alcohol in such cases, the parasiticide is brought not only in contact with the parasite, but is kept in contact with it for longer intervals than if the syringe were employed in the domestic treatment. I also blew into the ear some of the powder of salicylic acid and magnesia, already mentioned. This soon cleared the drum-head, and there were no signs of regrowth of fungus by the 5th of May, when the patient again passed from observation.

C. On July 19, 1878, there was a return of symptoms of aspergillus in the ear, which led me to think that perhaps the patient passed from observation too soon, in May, and that the fungus had kept a hold on the ear ever since.

The microscope revealing the presence of the inveterate fungus, the ear was carefully cleansed with alcohol and water, and equal parts of alcohol and water were instilled twice a day, by the patient at home, but she did not syringe the ear.

By the 31st of July, under this treatment, kept up each day, the membrana tympani once more became clear and lustrous; nevertheless, for the sake of safety, the patient was ordered to keep up the use of the alcohol as above stated, and this was done until the 9th of August, when the ear appearing well rid of the parasite, all treatment was discontinued, and the patient has not been seen since.

The formerly ulcerated space at the membrana flaccida was cicatrized and dry when the patient was dismissed. The short process was normal.

CASE XVI.—*Aspergillus nigricans in the left ear.*—John H., thirty-seven years old, Irishman, living in Philadelphia, groom and driver for a grocer, came under observation November 7, 1877. The patient complained of deafness in the left ear, which he said dated back two years. From the subsequent history, it seems likely he then suffered from an acute attack of otitis media catarrhalis. This hardness of hearing continued without much change and with tinnitus in the affected ear, until he applied at last for relief. His hearing was found to be reduced in the left ear to a foot for words of ordinary tone. The membrana tympani was largely perforated in the posterior and inferior quadrant. The inner tympanic wall was red and roughened. This reddened and secretory surface was touched with saturated solution of nitrate of silver, on the day of his first visit to me, November 7th.

By the 19th, the discharge had been checked for several days, but over what was once the region of the perforation there was seen a bluish-white membrane, and around it a yellow, pollen like, downy substance. The latter, under the microscope, was resolved into young fruit-heads of the aspergillus nigricans, with short stems and no sterigmata.

Patient complained of tinnitus and increase of hardness of hearing. By using the syringe, I removed all visible aspergillus, and relieved the tinnitus. By the 23d, two days later, the patient reported another attack of tinnitus and muffling of the hearing. Again, false membrane of fungous growth was found, some of which *extended to the tympanic cavity*, from the outer side of the membrana tympani, through the perforation.

The ear was now syringed with alcohol and water, and alcohol undiluted was instilled into the ear by the patient at home. The alcohol instillations were kept up for a month, as the aspergillus was found in small quantities once or twice within this period of time. On 28th December, the ear was found free from all traces of aspergillus, and the hearing had increased to two feet, against six inches on his first examination.

For the sake of precaution, alcohol was instilled into the affected ear for some weeks. There was no return of the fungous growth. By the 16th of April, 1878, the meatus was found to be somewhat reddish, but the membrana tympani was clear and the perforation had healed up, the cicatrix being somewhat depressed.

CASE XVII.—*Aspergillus nigricans in the left ear.*—Wm. H., aged twenty-two, born in Philadelphia, clerk in a large warehousing company, came under observation originally in January, 1875, for chronic purulent discharge from the left ear. The discharge was cured and the hearing very much improved, and the patient disappeared until December, 1877, when he again visited me. His statement now was that within four or five months he had noted a return of discharge from the previously affected ear. He had no reason to assign for this return of discharge, and in fact would not have consulted me for this had not the ear grown suddenly painful and robbed him of sleep.

His hearing in the left ear was found to be $\frac{0}{60}$ for the watch and almost contact (?) for the voice. The membrana tympani was macerated, its contours destroyed, and the wall at fundus of canal was dotted with four or five little granulations. The latter were thoroughly touched with a saturated solution of nitrate of silver, and the patient was told to syringe his ear at home. After the syringing he was to use instillations of a 3 gr. solution of sulphate of zinc. The next day the granulations were again touched as above.

In ten days from this time, the solution of zinc and the syringe having been used, there was scarcely a trace of discharge seen in the ear. The granulations had disappeared, the membrana tympani was retracted, malleus visible, but apparently adherent to the inner wall of tympanum.

Ten days now elapsed, when, on January 7, 1878, the auditory canal was found to be very much congested and the canal walls undergoing great exfoliation of epidermis. There were no granulations, but there was a slight discharge, for which was ordered the previous solution of sulphate of zinc.

Some suspicious scales, washed from the ear at this visit, were examined under the microscope, and found to contain masses of mycelial net work, but no fruit stalks of the aspergillus.

In this case I syringed the ear nearly every day for three weeks with alcohol and water, in about equal parts, and removed any suspicious-looking scales. At the end of this time no sign of aspergillus could be discovered, though there was a slight discharge from the walls of the external auditory canal. For this instillations of 2 gr. subacetate of lead to the fluid ounce of water were used.

On February 2d I noted that there was no discharge from the ear, and there had been none for a week, since, in fact, powdered alum had been blown into the canal, on the 26th of the previous month. The hearing had improved to one yard and the ear was easily inflatable by Politzer's method.

CASE XVIII.—*Aspergillus nigricans in both ears.*—Mr. W. A. T., thirty-four years old, born in Philadelphia, came under observation January 28, 1878, in the Philadelphia Infirmary for Diseases of the Ear. The patient states that he has been "deaf three years," after catching a heavy cold; never had running from his ear, nor is there an ear disease in his family. He has had rheumatism in his knees. His business lies along the wharf, and he is exposed to all kinds of weather. His hearing is reduced to a few inches for ordinary tones of speech.

For two or three weeks he had felt great itching and stinging in his ears, and he had picked at and scratched them until he had excited an eczema in each.

From the *right* ear cerumen plug was removed on 28th of January, when there was no trace of aspergillus found; but on the 2d February the aspergillus was found in this ear.

On the *left* side the meatus was very much swollen, the membrana tympani invisible. The eczema was great in the fossa antihelicis of the auricle, where, indeed, it had passed into ulceration.

For the eczema, Lotio nigra was prescribed. The most flourishing aspergillus nigricans was found at the outset in the right ear. Before any satisfactory results could be obtained the patient disappeared after the third visit.

It is interesting to note that in this case the aspergillus did not make its appearance in the right meatus until the cerumen plug was removed from the ear, which would seem to add confirmation to the idea that the wax of the ear tends to keep the fungus away, *i. e.*, the latter will not grow in or near healthy cerumen, as already alluded to in Case VIII.

CASE XIX.—*Aspergillus nigricans in the right auditory canal.*—Mrs. B. F., of Philadelphia, aged forty years, living in good circumstances, came under observation July 1, 1878. She states that she has been liable to attacks of earache and discharge on the right side for several months past, for which no reason could be assigned and which her family physician had failed to control. The hearing was not very much affected, however. There was history of a slight disease in this ear after scarlatina in early childhood.

The membrana tympani was found perforated at the posterior inferior quadrant, over which there was a small granulation attached to the dermoid layer of the drum-head. The condition of the ear seemed to denote that the disease had originated in the auditory canal and had ulcerated the drum-head from without inward. There was nothing visible in the ear which suggested fungous membrane, the granulation over the perforation was touched with saturated solution of nitrate of silver, and powdered alum was blown into the external ear. When the patient was seen a week later it was found that the perforation had closed and that the discharge had ceased. A week later still, the patient came with the statement that the pain had recurred and a slight discharge had reappeared. The membrana tympani was found perforated again. The patient was to use only warm-water syringing. In two days from this time large quantities of aspergillus nigricans were found in the ear.

Alcohol and water in equal parts were now dropped into the ear, and this was continued for three weeks, after which time no further traces of aspergillus were found. But the fundus of the canal still continued, until October 4th, to discharge a little, and the drum-head was covered usually with a drop or two of pus. This, however, was entirely checked by the use of the following prescription:

℞.	Liq. plumbi subacetatis............................	♏xx.
	Acidi acetici diluti..............................	♏vj.
	Liq. opii sedativi................................	♏xx.
	Aq. destill. q. suf...............................	f. ℥ j.

M.

S. Ten drops warmed, in the ear, as directed.

This prescription is one of Hinton's, used by him especially for furunculous inflammation in the meatus. I have found it very useful in any discharge arising from the walls of the external auditory canal.

On October 18th I made this note in the case: The use of the above prescription had the immediate effect to dry up the discharge. The ear looks very much better; the fundus is red and the membrana tympani congested at posterior part, but it is dry and scaly. Its anterior half is gray and looks as though opaque from old catarrh. The hearing is good; in fact it has never been impaired to any extent. Notwithstanding these good symptoms the patient has had some earache; but this is evidently neuralgic, from bad teeth. This, the pulling out of the defective teeth, four of them, proved to be the case.

By October 25th the membrana tympani was observed to be opaque and lustreless, but pale and *dry*, and the fundus of the auditory canal near the drum-head was pale, dry, and shining. Near the membrana tympani, on the posterior wall of the auditory canal, there is a round, flat hillock, shining, pale, and covered with skin, about as large as the head of a large pin. I did not touch it with the probe.

Case XX.—*Aspergillus nigricans in right auditory canal.*—Mr. W. E. L., forty years old, born in Philadelphia; manufacturer, living in the best of hygienic circumstances, came under observation September 14th, 1878. He states that during the past summer he had an attack of soreness, redness, swelling, and pain about and in the external ear, which was said by his family physician to be erysipelas. The history of this attack is not clear; the treatment of it consisted in painting the parts near the auricle with iodine and putting cocoa butter in the ear. The patient also has used for some time an aurilave, with which he has swabbed his ear until he has packed the canal with debris of ear-wax, pus, epithelium, etc., and brought about an excoriated state of the walls of the canal. I found the meatus of the affected ear somewhat tender to the touch, and firmly occluded by a hardened plug of cerumen, etc. The hearing was reduced to a few inches for conversational tones.

After washing out the hardened wax-plug the hearing became nearly normal. The membrana tympani was found covered with numerous granulations, and there were also some granulations in the meatus on its walls.

Treatment.—The granulations were touched with saturated solution of nitrate of silver at the first visit, and once or twice subsequently, and in the course of ten days the membrana tympani was found dry and shining, and the granulations entirely gone from the ear. Hearing normal.

Two days later, on 28th September, the patient called, saying that his ear had suddenly begun to feel sore and full, that a watery discharge came from it, and he could not hear as well as he had done a few days previously. On examination a foreign moist substance was seen filling the fundus of the canal. This, when washed out, proved to be suspicious-looking flakes or membranes. The meatus wall was free from false membrane, but moist, and the membrana tympani was lustreless, congested at the malleus and periphery, and dotted with suspicious white flakes. The canal was now syringed with alcohol and water.

The microscope revealed the presence of aspergillus in early as well as advanced stages, and there were some free spores, showing of course considerable age on the part of the fungus in the ear. The patient was told to use alcohol and water, in equal parts, in the ear twice daily and to syringe the ear with tepid water also twice daily.

In the course of two days the aspergillus seemed to have been destroyed, as the membrana tympani once more became smooth and shining. The skin on the walls of the auditory canal still looked red and decidedly thicker than the normal, as is apt to be the case where the "aurilave" has been habitually employed.

Age.—In the twenty cases just given, the ages varied from fifteen to sixty-seven years. The oldest and the youngest being males.

Ear affected.—Only the right ear was affected in 7 cases.
" left " " " " 9 "
Both ears were affected " 4 "

Sex.—Fourteen cases occurred in males and six in females.

Recurrences.—There were two recurrences within a year in Case XV., that of a young woman twenty-four years old. There was one recurrence within a year, in a gentleman sixty-two years old, in which case the recurrence was in both ears, as was the original attack. It may be said that there was a recurrence in Case VII., as Dr. H. N. Spencer had once found the fungus in Mr. J.'s ear before it was detected by the writer.

GENERAL REMARKS.

Symptoms.—The symptoms of the growth of this parasitic fungus in the external ear may be briefly given as, stinging, itching, with dulness of hearing, some pain and a watery but scanty discharge. The patient may finally complain of great pain and deafness, if the membrana tympani should become inflamed.

An ear thus affected will show, on examination, the presence in it of a grayish, sometimes mottled, flaky mass, or if examined in the earlier stages of disease, it reveals the presence of a false membrane neatly adapted to the membrana tympani and the inner part of the auditory canal. From this point the false membrane may, sometimes does, extend along the canal until it projects from the orifice at the concha of the auricle. When seen in its early stages of growth, the false membrane over the drum-head looks dry and downy, and somewhat shining; later it looks crumpled, and resembles a piece of wet newspaper. Any free edge of the membrane visible will appear much thicker than flakes of epithelium. Once seen, this parasitic membrane is easily recognized again. The diagnostic features of such a false membrane or fungous mass may be learned from what has already been said under the head of *Macroscopic Appearances*, p. 16, No. 1 of this Journal.

If any doubt should exist about the presence of aspergillus in the ear it is usually dissipated in a day or two, on the return of the patient, for, unless the treatment has been the proper one and very successful, the false membrane will have formed again. This, of course, removes all doubts, and should prompt us to great activity and watchfulness, or we shall have a stubborn disease to combat.

The microscope will remove all doubts as to the nature of any suspicious-looking flake or lump removed from the ear.

Etiology.—It must be evident to the reader of the details of the twenty cases here presented, that this disease is not confined to those living in poverty and squalor. In fact, my experience is the reverse of this. Only three cases, Nos. IX., XII., and XVI., could be said to have occurred in the poor and unclean. As long as the secretion of ear-wax is unimpeded and, when secreted, if the cerumen is not scraped away, no one is likely to be affected by aspergillus in the ear. If the ceruminous secretion is disturbed in any way, especially if now the skin of the auditory canal be abraded, anybody may be, probably will be, attacked by this parasite. The chief causes of the growth of this parasitic fungus in the ear, I find to be undue picking and scratching of the ear, and dropping in and leaving there oils and fats of various kinds and pieces of vegetable matter. These becoming rancid, or putrescent, a fitting soil for the aspergillus is given.

Next to these causes, is the neglect to wash the ear after it has been the seat of boils or any inflammation, which may leave behind it small particles of pus, serum, blood, etc. It is needless to say that all of the latter, when putrid, may become the nidus of a colony of aspergillus.

If the patient should be living in damp apartments, of course, this must be ended, if possible, either by cleansing and drying his dwelling, or by removal from this probable source of disease. If any other excitant can be shown to be the probable cause of the growth of the fungus in the ear, of course it must be removed, if possible.

I must repeat here what I have written elsewhere[1] concerning the protective function of cerumen. There is no evidence that the aspergillus grows on the natural ceruminous secretion of the auditory canal. It appears, indeed, that but for the presence of the cerumen in the canal, the ear might be invaded more frequently by the aspergillus, since the latter seeks a secluded spot for growing. The protection of the cerumen in this particular, is shown in the fact that in an ear, the canal of which is sheathed with ear-wax, aspergillus is rarely found at all, and never in a flourishing condition, while in an ear invaded by aspergillus, cerumen is rarely, if ever, found in a normal quantity or condition. (See Cases VIII. and XVIII.) In the latter case, had I not used different syringes for the two ears, I would have thought I had transmitted the parasite from the ear first diseased, the left, to the right ear.

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[1] **Philadelphia Medical Times, June 22, 1878.**

On this point of contagion I am very careful, for it would be very easy to convey aspergillus from one person to another, not only by the syringe, but by specula, cotton-holders, etc.

Treatment.—The treatment of aspergillus in the ear consists in killing and removing all parts of the plant, and especially all its germs. The syringe is the best means of removing the parasite, after it forms into false membrane, but if the latter be adherent, other mechanical means may be necessary. Hence I find it useful, if the fungous membrane has reached any size, or if it be visible as whitish flakes or spots, to wipe these traces of it away from or off the walls and membrana tympani, by means of the cotton dossil on the cotton-holder. This is easily done, and causes no pain to the patient. If these patches should be very adherent, they must not be forcibly removed. They are to be loosened then, either by time or by the use of a parasiticide. Experience shows me that these false membranes are not usually adherent, but easily detached. I have never employed but two parasiticides, viz.: alcohol, usually pure, but sometimes in various proportions with water, rarely weaker than one of the former to two of the latter, and hyposulphite of soda.

My solitary experience with hyposulphite of soda (Case XIII.), three grains to the fluid ounce of water, leads me to place it next to alcohol, as a destroyer of the aspergillus. In the future I propose to use it more frequently than in the past. I have found it of advantage to let the patient use the drops which are to destroy the parasite, without subsequent syringing on his part, for reasons given already in the treatment of Case V. Of course this omission of syringing on the patient's part can only be permitted when he can be seen by an aurist daily. The greatest gentleness is requisite in all cases of aspergillus in the ear, lest eczema be excited, since in all these cases the ear seems to possess a readiness to slip into the eczematous state.

Of course, should this complication arise in the parasitic disease, it must be combated on general principles. If possible, all fatty matter should be excluded from the treatment of eczema in these cases, since oleaginous substances feed the fungus[1] (see Case IX.). I have found that the eczema in these cases could be combated with the powder named in the treatment of Case IV. The prognosis in the disease is uniformly favorable.

In conclusion, it may be said the ear thus diseased should be carefully examined by means of the ear-mirror and speculum every day, and the treatment modified according to the stages of the disease. The least irritation of the ear, combined with the most efficient destruction and mechanical removal of the parasite, will give the most satisfaction to both surgeon and patient.

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[1] The investigations of Bezold, of Munich, have fully confirmed the fact that the use of oleaginous matters for the cure of ear diseases is very often the cause of the growth of aspergillus in the ear.

OTITIS INTERMITTENS.

BY J. ORNE GREEN, M.D.,

BOSTON, MASS.

M., aged twenty-three, applied to me at the City Hospital, in October, 1878, with an indefinite history of pain and discharge in the left ear. Examination showed a very narrow meatus, due to hyperostosis of the osseous walls, an abundant muco-purulent discharge, loss of nearly the whole drum-membrane, except a small triangular portion on each side of the manubrium, a granular condition of the tympanic mucous membrane, and closure of the Eustachian tube on that side. Douching and astringent instillations were ordered. The patient was not seen again for some two weeks, when the discharge had ceased and the tympanic mucous membrane was looking much better. She was not seen again for a week. She then complained of pain in the right ear, which had existed for twenty-four hours, and examination showed a slight, but marked catarrhal inflammation of the right tympanum. Inflation by Politzer's method was used, and two days after the inflammation was much less. The left ear had ceased to secrete entirely. The visits of the patient were very irregular, but in the course of the next three weeks she was seen several times, complaining sometimes of pain and discharge in the left ear, sometimes of pain and discharge in the right, and examination of this latter showed that a small perforation of the drum-membrane had taken place in the lower anterior quadrant.

Early in December, I was able to get the patient under regular observation, and found that, in reality, I was dealing with an intermittent catarrhal inflammation of the two tympana; at no time were the two tympana simultaneously affected, but she complained of pain in one ear, and examination showed catarrhal inflammation of the tympanic mucous membrane on that side. This would discharge for one or two days; the redness would then disappear and the discharge cease, but in a short time, generally almost immediately, she would complain of pain in the other ear; the same course was run, and that ear improved. On questioning her more carefully as to other symptoms, she said that almost every evening, about 6 P. M., she had pain in the face, teeth, head, and around the ear; that she soon became chilly, with flushed face, and remained so till about 10 P. M., when she retired; that she then began to perspire, and by 11 P. M. the pain was usually relieved, and she slept well till morning. These pains were sometimes on one side of the head and face, sometimes on the other side, and throbbing, discharge, and inflammation of the ear followed on the same side as the pain; the throbbing coming on during the night, and being followed in a few hours by a thin muco-purulent discharge. The condition of the ears I was able to speak positively about; the disease consisting of a catarrhal inflammation of the tympanum, as has been said above.

On inquiry as to her surroundings, I was told that she was employed as servant in a large boarding-house in the city, situated on what is known as the "new land," a district reclaimed by gravel filling from a marsh, but wholly free, so far as is known, from malaria; the district is, however, not free from suspicions of defective drainage. She, with other servants, slept in a room in which was an open tank of Cochituate water; the room, except for this and an offensive odor, was comfortable. The whole house has, for a long time, been noticed by many persons to have a disagreeable smell, and during last summer a child was sick with diphtheria, and was removed by order of the attending physician. In October a lady died there from typhoid fever, and my patient says that there has always been some one ill in the house for the last two years, and several persons have left the house on account of illness attributed to this odor.

For a short time in December, after the disease had continued for more than two months, I was able to get a daily record from her own statements. It is as follows:

Dec. 13th.—Chill, about six o'clock in the evening, with pain in the right cheek and right ear, followed by fever and profuse perspiration till eleven o'clock, when all symptoms disappeared.

Dec. 14th.—No chill, no pain, but a little fever in the evening.

Dec. 15th.—Chill about six o'clock, pain and throbbing in the left ear, pain around both ears, especially over the mastoid regions, fever and perspiration afterwards, ceasing about eleven o'clock; slept well; but on

Dec. 16th.—Muco-purulent discharge from the left ear for the first time for several days; occasionally sudden buzzing in the left ear, lasting about a minute, and accompanied by vertigo. No chill in the evening, slight fever, and little pain in both ears.

Dec. 17th.—Examined to-day. Tympanic mucous membrane of left ear very red, still secreting; right drum-membrane wholly free from congestion, the small perforation distinct and the tympanic mucous membrane seen through it dry and pale; by Valsalva's inflation distinct whistle through each ear. This evening, no chill, slight fever, little pain in both ears.

Dec. 18th, 19th, and 20th.—No chills, no discharge from either ear. Seen on the 19th, and both ears found free from congestion.

Dec. 21st.—Chill, as before, with pain, and throbbing in the left ear; pain, followed by swelling, of left side of face, fever and perspiration; ceasing as before.

Dec. 22d.—Discharge from the left ear. In the evening exactly the same history as on the 21st.

Dec. 23d.—Discharge from the left ear continues. In the evening, the same history of chill, fever, and pains.

Dec. 24th.—Discharge from left ear has ceased. No chill and but little fever; no pain.

Dec. 25th.—Chill, fever, and pain in the right ear and face.

Dec. 26th.—Examined; right drum-membrane very red, but no discharge through the perforation.

Dec. 28th.—Examined again, and found the tympanic mucous membrane on the right side discharging freely a thin muco-purulent secretion through the small perforation. The mucous membrane in the left ear quite dry and free from congestion. The tissues all about the right ear quite sensitive to the touch, but free from any swelling or redness.

By my advice she now entered the Hospital, and passed from my observation. While there she complained of frequent nausea, especially in the morning; pains in the limbs and left side, and a great variety of other symptoms so general and ill-defined that the diagnosis of hysteria was made; palpation showed that the spleen was enlarged.

After she left the Hospital, I again saw her at irregular intervals. The chills were occasionally felt, but at much longer intervals than formerly; fever and sweating were also much less common. The regular sequence of symptoms, so characteristic of the early course of the disease, disappeared. There was more or less constant headache, irregular neuralgic pains in the face, not as severe as at first, nearly constant nausea for a few days at a time, with occasional and irregular vomiting. The inflammation in the left tympanum, instead of being intermittent, became constant, and the ear discharged continuously for some two weeks, but gradually the inflammation subsided, and the discharge ceased; no attempt at a reparative process could be seen in it. The right tympanum became slightly congested, and discharged for a few hours once only, some ten days after she left the Hospital; the perforation gradually contracted, and when last seen was entirely closed. On questioning her, she said that the nausea and vomiting were always preceded for some time by a slight vertigo, which she had come to recognize as the invariable precursor of the nausea. The vertigo was at no time very pronounced or severe enough to cause staggering.

The preceding history is, I am aware, very incomplete as a scientific observation, but I have preferred to describe it just as it was presented to me. From the impossibility of carrying out any regular treatment, owing to a number of circumstances, which need not be detailed here, the observations have only reference to the natural history of the disease; as such, however, they seem to me of value. The patient, although of fair intelligence for her station, was extremely imaginative, and too much stress must not be laid upon her own descriptions. As will be seen, while in the Hospital the symptoms complained of were so multiform that nothing definite could be made of them. The condition of the ears was, however, a subject on which I could speak positively, wholly independent of her assertions; and as from the daily record an affection of the ears almost always followed the chills and pains and did not occur except as the sequence of those symptoms, I think her assertions as to the chills, pains, and fever are worthy of belief. On several occasions I found the face swollen and flushed on the affected side, with a marked degree of hyperæsthesia of the skin about the ear and in the meatus.

The chills, she said, were not severe enough to produce a real shaking, but only caused a decided cold feeling. The flushing of the face was very marked, and was often present when I saw her in the morning; the perspiration, she said, was often very profuse. The pains began in one or more branches of the trifacial nerves; sometimes in the cheek or temple, sometimes in the upper and sometimes in the lower teeth. They generally in a short time involved the whole side of the face, the mastoid region, and the depth of the ear on the same side; they were rarely on both sides at once. The hyperæsthesia, during the continuance of the pain, she spoke of as often extreme. When I first saw her the left drum-membrane had been nearly destroyed, and the tympanic mucous membrane was exposed; but as she said she had had trouble in that ear two years before, I think the loss of substance was due to some previous ulceration, and not to the existing disease. The right ear was at first perfect, passed through one or two attacks of simple acute catarrhal inflammation without injury; but finally, in another attack, the drum-membrane was ruptured by the secretion; there was, however, subsequently no ulceration and no further loss of substance, the perforation remaining as when first discovered. The appearance of the ears during the attacks was exactly that of acute catarrhal inflammation, the amount of secretion being slight in the right ear, but often quite profuse in the left. The very rapid diminution of the congestion and the cessation of the discharge was a marked feature in the case.

It will, I think, be immediately seen that the case differs from the ordinary forms of catarrhal inflammation in several particulars: in the preceding slight chill; in the very marked neuralgic affection of the branches of the trifacial nerve; in the fever, swelling of the face, and hyperæsthesia; in the relief afforded to the neuralgia by the perspiration; and, finally, in the congestion and discharge from the ear following the other symptoms after a few hours usually, and coming on rapidly, and diminishing with nearly equal suddenness; these attacks recurring every few days for four months. The direct connection of the aural affection with the neuralgia—or perhaps it should rather be said with the cause of the neuralgia—was so very decided that it could not be denied; in fact, the whole train of symptoms was so very regular that it is necessary to look for one cause for all of them. The case is the first of the kind that I have ever recognized in my practice, and corresponds so thoroughly with the description of otitis intermittens, which has been given by Weber-Liel, that I should give it that name.

In the *Monatschrift für Ohrenheilkunde*, No. 11, 1871, Weber-Liel described two forms of ear disease, dependent, as he thought, upon malarial poisoning: one an inflammatory affection, which he called otitis intermittens; the other a non-inflammatory affection, which he called otalgia intermittens.

Both varieties of the disease are referred by him to malarial neuralgia of the third branch of the trifacial nerve—the otalgia being a malarial neuralgia, pure and simple; the otitis being an inflammatory affection, the expression of a vaso-motor trophic neurosis accompanying or produced by the neuralgic affection. "After the irritating influence of the malarial poison in the first fever has ended in a severe paroxysm of pain, simultaneously existing in all the branches of the trifacial and neighboring nerves, the malaria is shown for a considerable time longer in the form of a vaso-motor neurosis, as the effect of which there is injection of the tympanic blood-vessels and a collection of muco-purulent secretion in the tympanum."

The symptoms and course of the ear disease are given by Weber-Liel as follows: Generally, although not always, there has been a preceding angina or naso-pharyngeal catarrh when, toward evening or in the night, there is a chill, either decided or perhaps so slight that it is scarcely noticed; this is followed by a feeling of fulness and roaring in the ears and sometimes by vertigo and pressure in the head. The patient passes a restless night, with profuse perspiration, but on the next day is perfectly well, and the ear symptoms have passed off. Forty-eight hours or so afterwards there is another chill, with shooting pains in the ears, deafness, and increased subjective noises, and examination of the ear often shows in this stage an exudation in the tympanum. As the stage of perspiration comes on after the chill, the patient falls asleep, to awake perfectly well, except that the subjective noises continue. If the exudation of the tympanum has ruptured through the drum-membrane, the discharge, which was perhaps profuse during the night, ceases by morning, and all pain is relieved. Tenderness of the tragus, which was marked during the pain, is also relieved. Thus the attacks continue, following the quotidian or tertian type, with intervals of perfect freedom from all general symptoms, although the local symptoms in the ears increase in severity, and the intermissions, so far as the ears are concerned, become less and less marked, till finally the ear symptoms are a constant irritation. Usually but one ear is affected. The mastoid cells may gradually become involved and be filled with pus. Local treatment, even paracentesis of the drum-membrane or perforation of the mastoid cells, affords only temporary relief to the constantly recurring attacks of pain. Neither the air-douche, warm or cold applications, or morphine injections, prevent the recurrence of the nightly pains. Quinine alone, in large doses, gives relief, and the earlier it is prescribed the more thorough and rapid is its action. The spleen is often found to be enlarged and tender. If the disease has continued for a long time, as it sometimes does for months, till the local changes in the ear have become thoroughly developed, the quinine is then of no value. In all cases of subjective noises and tympanic catarrh dependent upon malaria, large doses of quinine diminish the noises and deafness, while in the more common forms of the disease the same medication has the effect of increasing these symptoms very decidedly.

Voltolini, in the *Monatschrift für Ohrenheilkunde*, Nos. 5 and 7, 1878, describes several cases showing a similar intermittent character, which were due, as he thought, to malarial poisoning, and were only relieved by quinine.

In connection with the explanation of Weber-Liel, that the affection in these cases is an expression of a neuro-trophic disturbance of the trifacial nerve, an observation of Gellé in the *Gazette Médicale*, No. 1, 1878, is of interest. He divided the medulla oblongata in a dog, and on dissection afterwards found that the tympanum of the side operated upon was filled with an opaque fluid containing pus-cells, while the tympanum on the opposite side was free from secretion and showed a thin, pale mucous membrane. The changes, he considered, were due to the injury done to the descending branch of the trifacial nerve by the operation, and were in fact neuro-trophic disturbances in the tympanic mucous membrane.

Cassells has called attention in the Edinburgh *Medical Journal*, April, 1878, to the influence of sewer-gas in producing naso-pharyngeal catarrh and catarrhal tympanic inflammation, although his cases do not show the very decided intermittent character described by Weber-Liel and Voltolini; nor do his cases absolutely prove that the sewer-gas was the cause of the disease.

It will be noticed that the case I have described is in all its essential features similar to the otitis intermittens described by Weber-Liel, and I regret extremely that it was impossible to have the patient under closer observation. The most obscure point in the case is the cause of the disease. The patient had always lived in Boston and its vicinity, and, so far as I was able to learn, had never been exposed to malaria. The only possible cause that I could discover was the sewer-gas to which she had been constantly exposed; and the gradual recovery after she was removed from this influence, without other treatment, points to this gas as the source of contagion. Sewer-gas is generally recognized as one of the causes of general malaise and also the possible cause of some of the milder forms of catarrhal inflammation of the nose and pharynx; in this case it certainly looks as though it was the cause of an intermittent neuralgia similar—except perhaps in the irregularity of the intermissions—to that produced by malarial poisoning. The explanation of Weber-Liel, that the ear disease is a neuro-trophic disturbance of the tympanum, seems very satisfactory in view of the very intimate connection between the neuralgia and the tympanic inflammation.

TWO CASES OF INTRATYMPANIC VASCULAR TUMOR, WITH A PULSATING INTACT DRUM-MEMBRANE.

By ROBERT F. WEIR, M.D.,
Surgeon to the New York and Roosevelt Hospitals.

Pulsation at the bottom of the auditory canal has, since the time of Wilde, been regarded as pathognomonic of perforation of the drum-membrane. Though this statement has been repeated by various writers, and is undoubtedly in nearly every case correct, yet exceptions are occasionally to be met with. For instance, pulsation is, as has been remarked by Hinton and Roosa, encountered in a thin drum-membrane, in a state of acute catarrhal inflammation. This condition is, however, a rare one, for in an aural service of over eight years at the New York Eye and Ear Infirmary, I met with not more than four cases of this kind. But the following cases, with that reported by Dr. A. H. Buck, in another part of this journal, will show that this symptom of pulsation may be due to a cause that I would have said was hitherto unknown but for an article published by Schwartze,[1] in 1864, on the subject of "Pulsation in an uninjured Drum-membrane."

This author gives two cases of his own, and one communicated to him by Tröltsch. In that of Tröltsch there was pulsation in an intact drum-membrane without congestion; the case is imperfect in its details, and was confessedly obscure. The second of Schwartze's cases was probably due to acute catarrhal inflammation, as the pulsation disappeared with the congestion. In his first case, however, in a patient with symptoms of advanced chronic catarrh of the middle ears, there was found on the left side—the drum-membrane of which was white and somewhat lustreless—and near the apex of the light spot, a pulsating-point, the size of a pin's head, synchronous with the radial artery. These pulsations ceased when the Valsalvian experiment was resorted to, but returned in a short time. No injection whatever of the membrane was present. There was no tinnitus or pain in either ear, nor had the patient ever experienced any subjective sensations of sound. No treatment was apparently resorted to. Such was all the information that I was able to obtain, that threw any light upon the following case:

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[1] Archiv f. Ohrenheilkunde, Bd. 1, p. 140.

CASE I.—Mrs. J. A., ætat. 35, was sent to me in November, 1870, by Dr. J. T. Metcalfe, for deafness of the right ear, which had begun about a year previously, had rapidly increased during the past few months, and was associated with a disagreeable, though regularly pulsating, noise; there had been no pain or discharge. At times slight attacks of vertigo had been experienced.

On examination, H. D. right side = $\frac{\frac{1}{2}}{20}$; left, normal. After I had removed a slight layer of cerumen, a remarkable appearance presented itself. The whole drum-membrane was evenly and intensely reddened and strongly pushed forward in a bulging manner, except along the line of the malleus, which was situated apparently in a depression, and was marked at its free end by a white spot, in strong contrast to the other parts of the membrane. The whole membrane pulsated visibly and strongly, especially so superiorly, where there was a broad light spot. The pulsation was synchronous with that of the carotids, and was arrested by pressure on the artery of the corresponding side. No distinct vessels were to be seen on the membrane, only a general redness. By Siegle's tympanoscope, the drum-membrane could be forced in but little, and the pressure only rendered the pulsation more broadly and decidedly marked, and particularly so near the inner side of the malleus. By the otoscopic tube the heart sounds were distinctly heard, but not so on the sound side. No air could be felt to enter the tympanic cavity by Valsalva's or Politzer's method, nor by the catheter. No redness or abnormal change was noticed in the external auditory canal.

Thinking at first that I had to do with an exaggerated case of bloody serum in the middle ear, paracentesis was resorted to at the middle of the posterior segment, giving exit to blood which rapidly filled up the canal and flowed to the amount of ℥ i. in a few seconds, but was easily arrested by plugging the canal for a few moments with cotton. Attempts were made to inflate the tympanic cavity by the catheter, after bougieing the Eustachian tube up to its isthmus, but no air emerged from the puncture. On inspection no change in the appearance of the drum-membrane had resulted from the puncture, but three days later, when paracentesis was again resorted to, and after the cessation of a moderate hemorrhage, the drum was found collapsed and somewhat wrinkled; the hearing also was found to have increased to $\frac{2}{20}$. This improvement in hearing and condition of the drum-membrane only continued until the next day, and the pulsation was then felt as decidedly as ever by the patient, though to the eye it was much more feeble. I had by this time come to the conclusion that I had to deal with a vascular tumor in the middle ear, or that I had, according to Schwartze, a hypertrophied condition of the mucous membrane associated with an accumulation of bloody serum in the cavity. Leaning, however, to the first view, a consultation with Dr. Simrock, an acknowledged aural authority, was suggested and carried out. Dr. Simrock thought that the difficulty was due either to fluid in the middle ear, or, as he thought that he succeeded in forcing air through the Eustachian tube, that it was a collection of fluid in the tissue of the drum-membrane itself. A third puncture was made posteriorly, carrying the needle in until it reached the promontory—no air could be forced out. Convinced of the correctness of my diagnosis, on December 5th, a fourth puncture was made with a large needle, and a probe dipped in pure nitric acid was inserted through the opening into the middle ear. But little pain was occasioned by this treatment. As a result of the several punctures, it was noticed not only that after each the hearing distance increased, but that the pulsation became less distinct. This subsidence became more and more permanent, but the cicatrices of the punctures, yielding under the pressure from within, protruded almost teat-like from the drum-membrane, and after this application of acid a mass projected through the opening there made and spreading out, and pulsating faintly, obscured nearly the whole membrane, and assumed a polypoid appearance in the course of a week. This mass was punctured and a probe dipped in liq. ferri persulph. introduced into its depths, blanching it at once. The subsequent history is in brief this: the mass sprouting from the opening in the drum-membrane was with difficulty destroyed by the use of nitric acid applied first every second or third day for a number of times, afterwards, at intervals of one or two weeks (as the patient lived out of the city); and subsequently, as the tissue became tougher, by the use of the acid nitrate of mercury, which was carried, by means of a thin film of cotton around the end of a fine wire, through the tympanic opening into the cavity itself. At times considerable pain was caused by the applications, but, as a rule, they were less distressing than would have been anticipated. Several attempts were made to extract pieces of the mass for microscopical examination, and the one or two small portions so obtained were reported, by Dr. A. H. Buck, to show nothing but scales of epidermis and débris so changed by caustics as to be unrecognizable.

By this treatment, the tumor, in the course of four to five months, was apparently destroyed, and it was observed that in the later cauterizations, little or no hemorrhage occurred, and that when the punctures and applications—for they were sometimes conjoined—were carried into the tympanic cavity, the sensation was given that that space was more or less filled with a solid tissue. No air at any time was felt in middle ear.

On July 1, 1871, three weeks after the cessation of treatment, it is noted that H. D. = $\frac{2}{20}$; bottom of canal closed by a smoothly depressed fleshy-looking membrane, still considerably though irregularly injected. No pulsation whatever to be seen or heard by the physician, and only very slightly perceived by the patient.

Aug. 4.—Mrs. A. presented herself, on her way from Newport, stating that she only had occasional pulsation in the ear in the erect position, but always when in bed. On examination it was found that the membrane had changed from its former fleshy appearance to one more natural. Now the malleus could be defined; the membrane itself was still irregularly patchy, of a pink hue in spots, but with some translucency. By the use of Politzer's inflation, for the first time air is heard to enter the middle ear by the otoscope. Ordered Valsalva's experiment to be practised at home.

Nov. 14.—Drum membrane is quite normal in the posterior part. Malleus clearly seen. Anteriorly, two months ago, was seen a red bulging spot, as if the tumor was returning there, but this to-day is not seen; the drum-membrane at this point being now mottled with white bands running from malleus to the periphery. Tube slightly open by Valsalva's method; by Politzer's method air readily enters. H. D. = $\frac{3}{20}$–$\frac{4}{20}$. To use Politzer's bag daily.

Feb. 7, 1872.—H. D. = $\frac{8}{20}$. Only hears pulsation when in bed. Drum-membrane still mottled and sparsely injected. No evidence of return of tumor.

Dec., 1878.—No recurrence of the tumor. Reports herself as hearing well. Ear giving her no trouble whatever. As patient was met in the street, exact information could not be obtained.

In the second case there was apparently a vascular growth on the posterior wall of the tympanum, with an accumulation of serum overlaying it.

CASE II.—A negro woman, ætat. 35, was seen by me Dec. 8, 1870, with the history that for four years past she had had "beating noises" in the left side of her head, which were much increased by stooping, which position would also cause severe dizziness. Vertigo came on at times in the erect position. The hearing on the same side had also failed, and on her visit to me was $\frac{\frac{1}{2}}{20}$, while on the left side it was normal. She believed that her heart was affected, as she so distinctly and so persistently heard the sounds in her ear. There was, however, no cardiac lesion. She was much depressed and anxious by reason of her ear trouble. On inspection it was perceived that the posterior surface of the drum-membrane, and more especially its inferior portion, was of a reddish hue, with some vessels running over it, and that it was not only bulged outwards, but that it visibly pulsated synchronously with the heart. Considerable injection of the malleus was also present. The Eustachian tube was pervious. By Siegle's otoscope it was seen that a faint line half-way up the posterior segment was movable. Paracentesis was, therefore, resorted to and blood rapidly filled the canal, but was readily checked by a mop of cotton left a few moments against the drum. Politzer's inflation being then used, air freely escaped through the opening in the drum-membrane. After which H. D. $=\frac{8}{20}$. She was not seen again until June 1, 1871, when she returned with the statement that since the puncture she had been very much better, and her hearing had improved and kept in fair condition until a week previously, when the latter rapidly diminished. Now H. D. $=\frac{4}{20}$. Left drum-membrane translucent everywhere, except at postero-inferior portion, where a roundish red spot, the size of a small pea, was seen projecting forward, but not pulsating. By Siegle's apparatus fluid line was again detected; it was rendered more clear after Politzer's inflation had been successfully used. Projection outward apparently the same.

July 15.—Paracentesis used for a second time, causing not only H. D. to rise to $\frac{12}{20}$, but also disappearance of the pulsating noise and redness. This absence of pulsation was only noticed a few days.

Aug. 1.—Returned with symptoms of dizziness, deafness, and pulsation. Fluid seen in tympanic cavity. Redness and pulsation in drum-membrane observed as at first. Paracentesis, with needle carried in until it was arrested by bony resistance.

Nov. 7.—Repeated paracentesis. Says that after every puncture the sound is lessened in intensity.

Dec. 11.—Paracentesis twice in past week, and a probe wet with liq. ferri persulphat. also introduced.

She was not seen subsequently until Feb. 18, 1873, when the tumor was seen projecting still on the posterior and inferior segment of the drum, pulsating and of a red color. Dizziness complained of more than ever. H. D. $=0$. Up to March 24, paracentesis was performed three times, with the subsequent introduction of cotton wound round a cotton probe and dipped into acid nitrate of mercury. This kept the opening patent, and several applications through it of a solution of chromic acid (100 gr. to ℥ i.) were made. Pulsation scarcely seen, and heard much less distinctly by the patient. Dizziness has also ameliorated.

April 25.—For the past three weeks she has been free from vertigo and pulsating noises. After a rest of two weeks after last state, a new and long slit was made in the drum-membrane, and the chromic acid freely applied in the drum cavity by the cotton probe. Considerable swelling and discharge followed. This has nearly all subsided and she feels better in her head than she has felt in five or six years. She can now stoop down, and do her work without any unpleasant pulsation.

June 25.—Has had the paracentesis and chromic acid used but twice since last note. She has steadily improved, having had no pulsation and no dizziness until about ten days ago, when both were noticed after violent exertion.

By the speculum the lower part of the drum was found to be quite normal, save a few cicatricial traces. At the upper part posteriorly and advancing a little forward on the roof of the external auditory canal is seen a reddish mass about two lines wide and about three long, not pulsating, but evidently an extension of the angioma. She was then going into the country, and promised to return to me in the autumn if any further symptoms arose. She, however, did not do so. I have recently heard of her death in 1875, from phthisis. From her friends I learn that the noises in her ear slowly increased, and for several months prior to her death they caused her much annoyance and distress.

A CASE OF INTRATYMPANIC VASCULAR GROWTH, WITH MEMBRANA TYMPANI INTACT.

BY ALBERT H. BUCK, M.D.,

NEW YORK.

FEMALE, ætat. 33, anæmic in appearance, and with œdema of the lower extremities. March, 1871. Patient states that two months previously she began to be troubled with a peculiar noise in the right ear, resembling in character—as she described it—the croaking of a bull-frog. This noise came at regular intervals, synchronous—as she had herself noticed—with the heart-beat. She had never experienced pain in the ear, and could not remember ever to have had an otorrhœa. She had also never noticed any difficulty in hearing. On examination with the speculum and reflected light, the following condition of the parts was found: The meatus was normal. The membrana tympani was moderately sunken. The handle of the hammer was whitish and sharply outlined. In the anterior superior quadrant the membrana tympani appeared to be perfectly normal; in the posterior superior quadrant it was so transparent that the long process of the anvil, and head of the stirrup could be plainly seen through it. The entire lower half of the membrane presented a uniform and rather vivid red color, as if an exudation of blood or bloody serum lay upon its inner side. Such, at all events, was the diagnosis made at the time. Paracentesis was suggested, but the patient felt too weak and miserable to have anything done.

On the 17th September, 1873, patient presented herself at the N. Y. Eye and Ear Infirmary for the second time. Her story then was that two years previously she experienced some pain in the right ear, and afterwards observed that her hearing in that ear was very imperfect. From that time to this there had been a constant pulsating, roaring noise in the affected ear. On examination it was found that she could no longer distinguish the ticking of the watch in the right ear. The membrana tympani was found to have undergone the following changes: The lower half of the membrane was still as brightly red as in 1871, but at the umbo, passing from before backwards, the upper boundary line of the red region ran upwards and backwards, instead of straight across. The posterior half of the membrane—chiefly the lower two-thirds—was now markedly convex and pulsated synchronously with the pulse at the wrist. Suction with Siegle's apparatus gave marked relief for the moment, but the throbbing instantly returned when the instrument was withdrawn. No interference advised. Patient never returned.

Drs. Henry D. Noyes and Charles Laight verified the condition as described above.

The points of interest and importance in this case may be briefly enumerated, as follows:

1. The development of a new growth in the middle ear, without any apparent cause for such growth (such as inflammatory irritation), either in the past history or in the present condition of the ear.
2. The highly vascular character of the growth.
3. The slowness of its development.

BOOK NOTICES.

LES TUMEURS ADÉNOÏDES DU PHARYNX NASAL, LEUR INFLUENCE SUR L'AUDITION, LA RESPIRATION ET LA PHONATION; LEUR TRAITEMENT. Par le DR. B. LÖWENBERG. Avec deux figures intercalées dans le texte. Pp. 73. Paris: N. Adrien de la Haye et Cie. 1879.

IN this book, which treats of a subject highly interesting to aurists as well as laryngologists, the author, after alluding to the discovery of these adenoid tumors by Czermak as one of the first fruits of the use of his rhinoscope, and also to the great fact that these new growths are especially found in childhood and youth, then proceeds to a short historical sketch of the literature of the subject. Under this head a case of ear disease produced by these tumors is given, in which inflammation of the mastoid finally ensued. The operation of perforation of this bone was required.

Under the heading of anatomy the histology of these growths is given. It would appear from what the author here gives that the tissues in the naso-pharynx, especially the pharyngeal tonsils (Luschka), are most liable to give origin to these new growths. They are regarded as simple hyperplasia of the glandular tissues of the naso-pharynx.

These tumors are classified as—

1. Sessile or flat adenoid tumors.
2. Pedicellate or elongated.

Respecting their pathology it may be said, as already shown by the author in 1865, that there is a close relation between these tumors and the well-known granulations on the posterior wall of the pharynx. Dr. Löwenberg has indeed observed that the two forms of morbid growth are often found in the same individual.

In alluding to their etiology, the rigorous climate of the north of Europe is acknowledged as a fruitful cause of these nasal tumors, as shown in the writings of Mayer of Copenhagen, and other northern writers; but Dr. Löwenberg also thinks that social conditions have no less an influence in their production. No class is free from these tumors, the highest and lowest being alike affected.

In infants the prime cause is said to be the *lymphatic temperament*, which our author has found in the vast majority of infants affected with adenoid tumors of the naso-pharynx.

Heredity, too, plays a great part in their production, and the author here gives an account of a family in which the mother, thirty-five years old, and four children (from six years to eight months old) were simultaneously affected with these nasal tumors. The symptomatology, of course, becomes of the greatest interest and importance to us. One of the earliest symptoms is a patch of grayish green matter, more or less extensive, descending along the posterior pharyngeal wall from above and behind the palate. These masses are more or less streaked with blood, and are ejected either by the mouth or the nose. Granulations of the buccal pharynx are also usually found in connection with this stage. There is also more or less interference even in this stage with respiration, and the mouth is held open most of the time. Both digital and rhinoscopic examination should now be employed.

In subsequent stages the symptoms are not only peculiar, but very pronounced. These are considered first under the head of "Suppression of nasal respiration and its consequences." The latter may be briefly given as change in physiognomy, ill effects on the pharynx from chilling and drying, chronic rhinitis, weakening of the sense of smell, and inhalation of air not purified, as it would be were it drawn through the nostrils. General development in young children is interrupted; they snore inordinately, and the thorax is imperfectly developed, and in the end deformed; enunciation is defective (nasal), and in adults there arise in connection with these tumors obscure reflex diseases of the larynx, and in some instances the ability to sing suddenly ceases.

Under another head the author considers the "influence of adenoid tumors on the middle ear."

The most grave complication which attends these tumors, Dr. Löwenberg states, is otitis media, which is found in nearly three-fourths of all the cases. Catarrhal inflammation of the Eustachian tube is the most common form of these middle-ear complications; the suppurative form, with perforation of the membrane, occurs much more rarely.

The mode of action of these tumors on the ear is described as occurring in two ways: first, by keeping up in the pharynx an irritation which is easily communicated to the middle ear; second, by mechanically obstructing the mouth of the Eustachian tube. So great may be this latter mode of action as to interfere with the renewal of the air in the cavity of the tympanum and the mastoid cells. In that case there ensues a diminution of the volume of the air by a process formerly described by the author as a "quasi-respiratory change" (Progrès médical, le 24 Février, 1877).

The prognosis in these cases is generally very favorable, according to the more than ordinary experience of Dr. Löwenberg. Opinions of various authors as to the deleterious consequences, to the middle ear, of respiration by the mouth are alluded to. Among these are allusions to valuable writings of Catlin, the author, artist, and traveller, well known for his history of the North American Indians. An interesting fact narrated by this writer, in relation to the effects of breathing through the mouth, is that in two millions of

Indians visited by him not one was found who breathed through the mouth, no *one* deaf person, excepting four deaf-mutes. Furthermore, the testimony of the chiefs of 150 tribes as to their experience for ten years was that not one of them could recall a single deaf subject, nor even one hard of hearing. Dr. Cassell's and Mr. Toynbee's observations on the evil effect of oral respiration are also alluded to.

In the diagnosis of these tumors of the naso-pharynx two methods of examination are given, viz.: The *rhinoscopic examination* and *digital exploration.* Dr. Löwenberg states that the former method is often more satisfactory if the naso-pharyngeal douche precedes the examination. To facilitate the use of the rhinoscope the patient is always asked to *breathe* or *blow through* the nose, which of course, the reader knows, can be done only with the velum down. The second method, the digital examination of the naso-pharynx, is carefully explained, though the author disclaims any originality in its employment, as it is a well known and somewhat old means of examination of naso-pharyngeal polypi.

The way to make this exploration is thus given by our author: "Introduce through the mouth the index finger crooked, with the dorsal surface downward, and pass it behind the velum palati. Having reached the naso-pharyngeal cavity, the posterior openings of the nares, the lateral and superior surfaces of the pharynx, the openings of the Eustachian tubes and the postero-superior surface of the velum palati, are to be successively explored with the tip of the finger."

All of which manipulation requires a long index finger, and, as the author says, the manipulation must be conducted *cito, tuto et jucunde.* The patient should be told to try to breathe *through his nose,* as this will tend to keep the velum down. The finger-nail on the exploring finger must be pared closely, and the finger well oiled or made bland in some equally good way. Usually, after such palpation, blood will be noted on the end of the finger, which is due chiefly to the extreme vascularity of these growths. The exploration is further aided by having the patient throw his thorax forward and his head backward.

The two methods thus given should be uniformly combined, and, in the author's opinion, the time and patience thus expended will be amply repaid by the precision in diagnosis and the radical cure which may then be made.

Dr. Löwenberg then alludes to the method known as the *inspection of the superior pharynx through the nasal passages,* and he admits that it is possible to recognize the presence of adenoid tumors by the methods of Zaufal and Michel. It is also possible to diagnose, with some certainty, the presence of these growths by the ordinary act of catheterization of the Eustachian tube. Nevertheless, our author urges us not to forget that absolute certainty is to be gained only by palpation and pharyngoscopic inspection.

Differential diagnosis.—The differential diagnosis is to be made between these tumors and simple chronic coryza, hypertrophy of the tonsils, nasal polypi, and naso-pharyngeal polypi. The most usual mistake is to confound the presence of these growths with simple chronic coryza and enlarged tonsils; rarely with nasal or naso-pharyngeal polypi. At this point our author remarks: "Coryza and hypertrophy of the tonsils are usually regarded as of slight importance; people delude themselves with the hope that all will come right at puberty—a period reputed to be all-powerful, not only for the cure of the diseases just alluded to, but also for others, as for example, diseases of the ear, as *we see every day.*"

"Unfortunately, none of these diseases heal spontaneously, and the sad results of this *laisser-aller* treatment are not long in showing themselves in a dull aspect, ridiculous enunciation, etc." The distinctive symptoms of simple chronic coryza are: permanent obstruction of the nose, alteration of the voice, which becomes more or less nasal, abnormal secretion, giving place sometimes to an abundant running, sometimes to dry and firmly adherent crusts. The senses of taste and of smell are impaired, and in some cases the odor of the expired air is offensive. If the obstruction of the nose is complete, all the train of circumstances of buccal respiration may become manifest. The danger here is in ascribing these symptoms entirely to the chronic rhinitis, when really the case may be complicated by the presence of adenoid tumors in the naso-pharynx. In the presence of this resemblance of symptoms the author has but one advice to give, viz.:

"Be sure to employ the physical means of examination of the nasal pharynx in the case of all patients who present, either to a small or large degree, any phenomena suggestive of chronic coryza."

Hypertrophy of the tonsils has frequently been blamed for results due entirely to the presence of adenoid tumors of the nasal pharynx. But Dr. Löwenberg doubts whether enlarged tonsils can produce symptoms similar to those of the adenoid growths under consideration. The two conditions may be present at the same time; but if now the tonsils only are removed, the enunciation will *not* be improved, nor will the respiration. And this explains, in our author's opinion, the ill results of excision of the tonsils in so many cases. The real cause lies in the nasal pharynx, but has escaped detection.

Where these two conditions exist together, *ablation* of the adenoid tumors in the nasal pharynx, without any treatment whatever of the enlarged tonsil, has removed all symptoms usually attributed to hypertrophied tonsils alone—a most significant fact.

But, to make sure the diagnosis, here again the author urges the use of physical exploration as already set forth, *especially palpation.* It is here denied to enlarged tonsils the rôle they have been supposed to play in causing catarrhal deafness.

To distinguish nasal polypi from adenoid growths in the nasal pharynx, the use of physical examination will usually be sufficient. Some useful suggestions of the author are, that though these adenoid tumors are usually found in infancy and in youth, nasal polypi are found at all ages—chiefly, however, in adults. The special symptoms of a nasal polyp are more or less discomfort in the nose, a sensation of a foreign body in the nostrils—a feeling which is entirely wanting in adenoid affections. Deafness, too, which usually accompanies the latter, is rarely found with nasal polypi, to which usually are joined disorders of the secretion of tears. Usually nasal polypi make their appearance at the anterior or posterior openings of the nares, whereas adenoid growths never extend beyond their pharynx, the place of origin. Other well known symptoms of nasal polypi are given, but need not be mentioned here.

To distinguish between adenoid growths of the pharynx and naso-pharyngeal polypi, it may be sufficient for us to bear in mind that the marked tendency to invade successively the interior of the pharynx, the nasal fossæ, and adjacent cavities, such as the sinuses and the orbit, on the part of naso-pharyngeal polypi, will serve to distinguish them from the adenoid growths.

Prognosis.—The author is inclined to admit that these tumors may disappear spontaneously. But he further says, though they develop in infancy, to remain stationary in youth, and to finally disappear in adult life, they will not take with them the more or less grave consequences which their long presence in the pharynx has induced.

Treatment.—The treatment of these tumors is divisible into *general* and *local*.

The first is to be adapted to the diathesis, viz., the lymphatic, in which these growths are most commonly found, and should therefore consist in good hygiene, plenty of exercise in the open air, combined with rational gymnastics calculated to stimulate respiration, circulation, and general nutrition. In addition, there may be prescribed cold bathing (the sponge-bath), cod-liver oil, bitter tonics, preparations of iodine, iron, seaside bathing, and saline and sulphuretted mineral waters. Irritation of the pharynx must be most carefully avoided; hence, very hot and irritant food or drink, alcoholic stimulants, tobacco, excessive exercise of the voice and inhalation of bad air, must all be most positively prohibited.

Local treatment consists in cauterization and ablation.

The first form of treatment is the best when the vegetations are flat or sessile, where of course there is little chance for the instrument to take a good hold. Furthermore, in many cases no other method will be permitted by the patient or his friends.

The porte-caustique preferred by the author is a cylindrical shaft of silver, 23 ctm. long and 4 mm. in diameter. The end of this instrument is shaped into four facets, each one roughened so as to facilitate the adherence of the caustic. This, as the author states, is modelled according to the suggestion of Politzer, and is somewhat simpler in construction than the porte-caustique of Meyer of Copenhagen.

It is to be introduced through the mouth and into the nasal pharynx, where the granulations and tumors may be cauterized by the substances thus conveyed to them. So far the author gives preference to nitrate of silver fused on the end of the caustic-holder. In cases of little children, or of fractious patients, where it would be difficult to introduce the caustic accurately, the author advises the employment of nitrate of silver mitigated with nitrate of potassa, in the proportion of two of the latter to one of the former. If the vegetation is only on one side of the nasal pharynx, only one side of the quadrangular prism at the end of the caustic-holder is to be armed with melted silver nitrate. Were the entire end covered with caustic on all sides, and then plunged into a pharynx only diseased at one point or on one side, harm would of course be done to healthy tissue.

Cauterization is to be applied by the aid of the rhinoscopic mirror whenever this is possible. If it is not, the index finger of the left hand is to be introduced into the pharynx and is to guide the caustic to the diseased tissues. Should the velum become unmanageable, the same means—respiration by the nose—is to be resorted to, as already described.

But in many cases—as in children—the finger cannot be introduced into the pharynx, for the purpose of guiding the caustic, without irritating this cavity and bringing about a great contraction on all sides, which, of course, would render imminent the risk of cauterizing healthy parts. In order to obviate such dangers, Dr. Löwenberg shields the cauterizing end of the holder with a rubber tubing, 2 ctm. long and 6 or 7 mm. in diameter, and inserts it without the aid of the finger. When the diseased spot is reached by the holder, the end of the latter is pressed against the morbid growth, and thus the rubber cover is pressed back and off the caustic. When the caustic-holder is removed, the act of withdrawing it will usually cause the rubber covering to slip over the end of the instrument again, and thus shield the parts passed over by it as it leaves the pharynx.

In order to guard against the evil effects of any surplus of silver that might be—and sometimes is—left behind, Dr. Löwenberg always employs salt-water, by means of the naso-pharyngeal douche and by gargling; and if there is any suspicion that a fragment of the caustic may have slipped into the pharynx or farther down the digestive tract, the patient is made to drink salt-water. If there is reason to believe that a fragment of the caustic has been detached, and left in a crevice or a fold in the naso-pharynx, the surgeon must either be sure that he has entirely neutralized it, or he must remove it, or cause it to be expelled before his eyes.

After one cauterization another must not be made until the eschar has fallen off. Twenty-four hours usually will be sufficient for this to occur.

Dr. Löwenberg suggests a special way of gargling, as follows:

"The patient must throw his head backward horizontally, and perform certain motions denominated those of quasi-deglutition, but not comprising the last stage of this physiological act, viz.: definite swallowing. By this means it will be possible to force the fluid much higher behind the velum palati than he can by the ordinary method of gargling. In some instances the liquid taken into the mouth may, by this method of gargling, be thrown out through the nose. Furthermore, the powerful muscular contractions thus brought into action causes complete detachment and expulsion of all secretions, which is a great relief to the patient."

Wendt and Guinier are quoted by the author in support of this procedure.

Ablation of these adenoid tumors is to be accomplished in several ways—the most common being by means of the cutting curette, by constriction and crushing, and by the use of an annular knife. The author also admits that these growths may be removed by the galvano-cautery, but he has never employed it for this purpose.

Dr. Löwenberg has devised an operative procedure, to which we shall refer farther on. As he has often used the cutting curette with advantages we shall allude to his way of employing it. When possible, it is inserted under view by means of the rhinoscope; but where this is not practicable, the curette is introduced in the same manner as the porte-caustique and guided by the index finger of the left hand. The morbid growths are then cut by a kind of scraping process (raclage) with the curette.

But here, too, the index finger is not tolerated in many cases, in the nasal pharynx, at the same time with the instrument. In such cases the position of the tumor is to be first well ascertained by means of the finger; then the curette, protected, like the porte-caustique, with rubber tubing, is to be inserted and the index finger again introduced, if possible. At the moment of cutting the rubber tubing is to be pulled away from the curette, *i. e.*, we suppose, down the shaft or handle of the instrument; or, if the finger cannot be thus employed, the cutting edge is to be pressed against the morbid growth, and thus the tubing will be cut through and pushed away, and the blade liberated. The hemorrhage is sometimes copious, but this our author proposes to control with the naso-pharyngeal douche, by thus introducing cool water and solutions of alum. (Would not warm water be safer, and perhaps just as good an hæmostatic? R.)

This curette is a spoon-shaped steel implement, the blade of which is 7 mm. in diameter and the handle of which is 15 ctm. long.

Constriction and crushing are applicable, the first to pedunculated growths, the second to the sessile ones.

Constriction is to be applied by means of a snare similar in construction and principle to the instruments of Maisonneuve and Wilde. Crushing can be accomplished by any means which can firmly and skilfully pinch the tumor.

The annular knife of Meyer is discarded by our author, because he has found it impossible or very painful to the patient to introduce it through the nostrils, as it is designed to be used by its proposer.

Dr. Wendt's experience as to its positive harmfulness by exciting, in at least two cases, acute purulent otitis media with perforation of the drum, is adduced by Dr. Löwenberg against this knife.

Dr. Löwenberg's own method of removing these tumors is by employing an instrument of his own device. This consists in a forceps ending in two cutting blades, the edges of which shut against each other when the instrument is closed. It has a double curve, thus resembling the letter S. The joint is near the blades, so as to give the greatest possible length and leverage to the handles. The ends cut by being brought together; they are hollowed out on their inner surface. These are used in the following manner:

"Guided by the rhinoscopic mirror, or by the index finger of the left hand, the forceps is introduced closed. The instrument is then opened and the vegetations are cut off as close to their base as possible. The growth cut off is usually brought away with the instrument."

The author, having used this instrument frequently, recommends it highly, not only for the removal of adenoid growths, but also for the destruction of nasal polypi. The instrument is about 24 ctm. long and 7 mm. thick. The latter is the length of the cutting edge.

The treatment of concomitant and consecutive diseases is considered under that of pharyngo-nasal affections, and as measures taken against buccal respiration and its consequences, and therapeutics of diseases of the ear.

In the treatment of attendant inflammation of the nose and naso-buccal pharynx, alum in form of douche and gargle is specially recommended—the gargling to be practised in the peculiar way already detailed. In all nasal applications chloride of sodium must be present in the proportion of from 1 to 3 per cent. In order to correct the bad results of breathing through the mouth, Dr. Löwenberg thinks that in some cases a cure may be obtained by causing the child, who has incurred this bad habit, to wear a head-gear, which will hold the under jaw close against the upper. This can be made of some strong substance, like cloth, and consists in a chin-piece held in position by two bands from each side, crossing the top of the head at right angles to each other.

The treatment of the diseases of the ear arising in these cases is to be preceded by the removal of the adenoid growths, otherwise there will be no beneficial results. There are many points of great interest in this chapter, but we pick out but one statement for quotation. It is that our author prefers, in all cases of purulent catarrh of the middle ear, absolute alcohol in varying proportions—with water at first, and finally pure.

In closing this review, we cannot refrain from saying that we consider this book a valuable addition to scientific otology, and that we have been deeply interested as well as instructed by its perusal.

AUDITORY AFFECTIONS IN BRIGHT'S DISEASE. Par PAUL PISSOT. THÈSE POUR LE DOCTORAT EN MÉDECINE—Faculté de Médecine de Paris. April 4, 1878.

THE candidate has confined his considerations to three forms of affections of the hearing which arise in Bright's disease, viz.: tinnitus aurium, half-deafness, and complete deafness. His conclusions are that affections of the hearing may arise either at the beginning or during the course of the disease. Intermittence seems to be a characteristic of these forms of deafness, which may be contemporaneous with the œdema, or they may precede it. They appear with all the forms of the disease, and are manifested with variable intensity. To what special lesion of the ear, or of the nerve of hearing, these symptoms are attributable, this writer cannot say positively.

According to examination of these cases, made by Delacharrière, rupture of the membrana tympani, abnormal vascularity along the manubrium, and sclerosis of the tympanum may be adduced as causative forces. It is held that the hypothesis of Rosenstein, according to which there is an œdema in the course of the nerve within the cranium, may explain the intermittence and variations of intensity in these morbid manifestations.

This process may be, the author thinks, analogous to the œdema of the glottis and the vocal cords, noted in Bright's disease, by Fauvel, in 1864. A similar symptom was noted by Sée.

It may therefore be supposed that the symptoms in the ear are attributable to an œdema of the sheath of the auditory nerve: an œdema which, by its greater or less intensity, gives rise to the intermittences so frequent in the course of this symptom.

PETITION ASKING THAT CANDIDATES FOR THE DEGREE OF DOCTOR OF MEDICINE BE REQUIRED TO PASS AN EXAMINATION IN OTOLOGY. By PROF. VON TROELTSCH.

A commission having been appointed by the Chancellor of the Empire, to determine what reforms are needed in the requirements exacted of candidates for the degree of doctor of medicine, Prof. von Troeltsch addressed to these gentlemen a petition setting forth in detail the reasons why a certain degree of knowledge about the ear is essential to every practising physician, and urging upon them the necessity of making such knowledge obligatory upon those who apply for the medical degree. The editor regrets that he is unable, through lack of space, to publish this petition in its entirety; he will give, however, as full an abstract as circumstances will permit.

Prof. von Troeltsch first alludes to the fact that the governments of several of the German States, as well as that of the German Empire, have recently extended the list of obligatory studies so as to include ophthalmology. In arriving at this decision they were governed by the following considerations: 1, Diseases of the eye are very common; 2, these diseases and their sequelæ may damage the people—and therefore the State—to a serious extent; and 3, this damage may be lessened just in proportion as physicians are taught how to recognize these diseases and to treat them properly. The petitioner then proceeds to discuss the question whether these three weighty considerations do not apply with equal force to otology. In the absence of statistics that can lay the slightest claim to accuracy, he is obliged to prove the great frequency of diseases of the ear by other means. He refers, in the first place, to the fact that almost every city of any size, in Germany, possesses at least one physician who devotes himself, either chiefly or exclusively, to the practice of otology. He also states that seventeen of the German universities, seven of the Austrian, and four of the Swiss, are provided with instructors in this branch of knowledge. "Surely such a large number of otologists could not exist unless there were also a correspondingly large number of patients suffering with disease of the ear." He next calls attention to the great frequency of "colds in the head" and catarrhs of the naso-pharyngeal mucous membrane, quite a large proportion of which, as every physician can testify, are associated with a more or less active affection of one or both ears. It is also well known how frequent, especially in childhood, are aural affections in connection with influenza, diphtheria, whooping-cough, scarlet fever, measles, tuberculosis of the lungs, etc., all of these in turn being the commonest diseases to which the human organism is liable. Scrofula and constitutional syphilis also furnish a large number of diseases of the ear. The facts, therefore, justify the statement that aural affections are among the most common ailments that befall man in these latitudes, and that they occur just as frequently as do affections of the eye.

With regard to the amount of damage inflicted upon the individual—and, secondarily, upon the State—by diseases of the ear, it is only necessary to point out how frequent are the instances of children who are prevented from, or hindered in, acquiring a suitable education through hardness of hearing. "How many otherwise promising and bright youths have been compelled to leave the high school, the university, or other institution of learning, by reason of their defective hearing? Among instructors, officers, judges, and other officials, not a few have been deprived, through deafness, of the opportunity of giving the State the full measure of their services. From these sources alone, then, how great has been the annual pecuniary loss to the State?" Upon purely financial and politico-economical grounds, therefore, every well-organized State should, as Von Troeltsch maintains, see to it that its medical men acquire a knowledge of the diseases of the ear and the proper methods of treating them.

But there are still other and more serious results connected with certain forms of ear diseases. Purulent inflammations of the ear may be followed by abscess of the brain, by phlebitis, by pyæmia, and by other infections and metastatic diseases, more particularly acute tuberculosis. No statistics exist which show, with the slightest approach to accuracy, how many lives are lost annually in Germany as a result of purulent inflammation of the ear—lives that might nearly all be saved if the ear could receive proper attention at the right time. If the results of neglect be compared in the two classes of diseases, it will readily be seen that affections of the ear entail a far greater loss of life than do those of the eye.

Finally, attention is called to the fact that (according to George Mayr) there are 38,489 deaf-mutes in the German Empire. Of this number it may be safely said that the larger half represents cases of congenital deaf-mutism. Of the smaller half, in which the condition was acquired, quite a large number must be attributed to serious cerebral disturbances, which probably no treatment could influence. In a large proportion of the remaining cases—say in one-fifth, or 3,000—an early and energetic treatment of the aural affection would, in all human probability, have *at least* saved a large part of the child's hearing power.

In answer to the third question—Whether the serious results referred to can be materially diminished by properly educating physicians with regard to such matters?—Von Troeltsch unhesitatingly answers yes. While admitting the fact that very many cases, especially chronic ones, are not amenable to treatment, he insists that in their early stages diseases of the ear are quite as amenable to treatment as any other class of diseases.

Von Troeltsch lays stress upon the necessity of compelling candidates for the degree of doctor of medicine to acquire a certain measure of knowledge of aural matters. So long, he says, as the authorities themselves tacitly admit that a knowledge of otology is not essential to the practising physician, so long, we may rest assured, will medical students as a body neglect to inform themselves upon such matters. It is neither necessary nor practicable to insist upon an extensive knowledge in this department, but the candidate should be required to give evidence of his ability to obtain a view of the membrana tympani on the living or dead body, and to interpret the pathological changes that may be there present. He should also be questioned on one or two practical points, for the purpose of ascertaining whether he is familiar with the more important diseases of the ear and the measures best suited to relieve them.

Such is, in brief, the line of argument pursued by Von Troeltsch in his petition to the commissioners appointed by the Chancellor. At a later date we hope to be able to report that his very reasonable request has been granted.

REVIEWS.

Marked Stenosis of the Foramen Rotundum. Zuckerhandl: *Monatsschrift für Ohrenheilkunde*, Juli, 1878.—In both temporal bones of a man the promontories extended backward directly to the posterior tympanic wall, and the foramina rotunda were narrowed so that a bristle could hardly be inserted. In addition, the eminentiæ pyramidales were lacking, in their places being depressions at the bottom of which were openings into the Fallopian canals. The part of the temporal bone behind the sulcus tympanicus, which forms the canaliculus chordæ, was so strongly developed that it extended forward beyond the sulcus. This latter condition Zuckerkandl asserts he has found several times.

Softening of the Ossicula. Hartmann: *Archiv für Ohrenheilkunde*, Vol. XIII., part 4, p. 259.—In a man who died from chronic phthisis, and who had suffered for years from chronic otorrhœa, Hartmann found extensive destructive processes in both tympana, such as are not infrequently seen with chronic purulent inflammation of long standing. In addition to these common pathological changes the basal half of the anterior crus of the left stapes was wanting and the posterior crus and head were so softened that they could be bent in any direction; the right stapes was normal in form, but likewise softened so that its head could be bent at a right angle. The bases of both of these bones were attached with the normal firmness in the fenestræ ovales. Microscopic examination showed the normal bone corpuscles in the crura of both stapes.

Further examination of the skull showed similar softening in the squamous portion of both temporal bones, from which fact Hartmann concludes that the marasmus accompanying the phthisical process was the cause of the decalcification and softening of the bones.

A Peculiar Peripheral Opacity of the Drum Membrane and its Significance. Gruber: *Monatschrift für Ohrenheilkunde*, Sept., 1878.—In his work on diseases of the ear, Gruber has called attention to the fact that opacities of the drum membrane are sometimes caused by adhesion of the surfaces of a fold of the membrane, as occurs occasionally when that structure has become relaxed from any cause. In an article on the same subject, published in 1871, he says that partial or total relaxation of the drum membrane is the common cause of the formation of these folds, which may occur single or in numbers in one and the same membrane. He now describes a special form of these folds which occurs on the posterior upper margin of the membrane, close to the edge of the meatus. When this fold projects into the meatus with its free edge, a yellowish color is given quite distinct from the rest of the membrane; when, however, its free edge projects into the tympanum, a corresponding depression is visible externally. Such folds he thinks occur not infrequently, and when the free edge projects into the meatus, allowing the mucous surfaces to lie in contact, adhesions are formed between these surfaces, and the result is an opacity. Where the fold, however, projects inward, he has never seen the surfaces unite, as would be thought to be the case from the fact that the external surface of the membrane is covered with epidermis. On an opacity thus formed not infrequently a lineal prominence is seen which is the free edge of the previous fold of membrane.

The influence of such an opacity on the hearing is very variable; sometimes by the adhesion of the surfaces of the original fold the tension of the drum-membrane is brought more nearly to the normal, and the formation of the opacity actually produces an improvement in the hearing over what it was when the fold existed. In the majority of cases, however, the longer the opacity has existed the worse is the hearing, from the fact that it produces a hyper-tension of the membrane, with resulting abnormities in the position and articulation of the ossicles.

In treatment, Gruber recommends first a trial of the air-douche, which, however, should not be used for any length of time; if this is unsuccessful, multiple perforation of the opacity is advised, with an after-treatment which shall tend to produce a development of connective tissue between the edges of the wound, thus producing relaxation of the membrane.

LECTURES ON SOUND. TYNDALL: *London Times*, Feb. 21, 1879.—On Feb. 13th Prof. Tyndall, opened a course of lectures on sound, at the Royal Institution.

After briefly describing the anatomy of the ear, and alluding to the external physical motion of waves or pulsations becoming internal psychical sensations, he spoke of the importance of having at the outset of the study of sound a clear mental picture of sound-waves, of the rarefactions and condensations of the air caused by sound-vibrations. Two sets of balls united by coiled springs—in one set the springs being stronger than in the other—were used in illustration of the motion of the air-particles passing from one to another, the impetus given to them, and of the fact that the stronger the spring the more rapidly the impetus is conveyed.

In the air the elasticity of the spring, as Robert Boyle calls it, influences the rate at which sound travels; and while, for instance, at a temperature of 32° F. the air transmits sound-waves at the rate of 1,090 ft. per second, every variation in temperature alters the rate of this transmission; and in allusion to

Newton's attempt to reconcile his theoretical calculation of 916 ft. per second with the experimental results of 1,090 ft. per second, mention was made of the omission to take into account the warmth developed by the sound-wave in its own path.

In the course of the lecture, reference, illustrated by experiment, was made to the observations of Prof. Stokes on the mobility of air and of hydrogen in response to the vibrations of the tuning-fork, and to his explanation of the phenomena observed in fog-signalling, in the effects of wind on sound, where there are presented conditions analogous to those concerned in the refraction of light.

VELOCITY OF VERY LOUD SOUNDS. W. W. JAQUES: *American Journal of Science and Arts*, Feb., 1879.—The results of automatic measurements of the velocity of sound in the immediate vicinity of a cannon, as made by the author, serve to show, as he states, that the velocity near a cannon is considerably different from that at a distance, and point out a considerable error that has been introduced into the most important measurement of this quantity. These very interesting experiments, consisting in the automatic measurement of the velocity at different distances, varying from ten to one hundred and ten feet from the mouth of the cannon, by means of a series of membranes electrically connected with a chronograph, were conducted in the following manner:

In the midst of a large level field was placed a six-pound brass field-piece. In the rear of this, at distances of ten, thirty, fifty, seventy, ninety and one-hundred and ten feet from the mouth of the cannon, were placed the membranes of thin rubber nine inches in diameter and standing three feet above the ground. To the centre of each membrane was attached a small shelf of brass, resting upon which was one end of a steel spring. The wire bringing the current of electricity from the chronograph house was attached to this spring and a second wire returned from the brass shelf to the chronograph, consisting of a uniformly rotating silver cylinder coated with lampblack, which was made one pole of the secondary coil of an inductorium the primary coil of which was in circuit with the membranes. The other pole of the secondary coil was a fine metal point brought very near the surface of the cylinder.

When the spring rested upon the brass shelf attached to the membrane the circuit was closed, the passage of a sound-wave moving the membrane would break this circuit and cause a dot record on the cylinder of the chronograph, by the passage of a spark from the metal point through the lampblack to the metal cylinder.

When the spring fell from the brass shelf it rested on a contact-point, from which a wire ran to the next membrane of the series, so that the current, after being broken at the first membrane, was made again through the second before the sound-wave reached it.

The makings and breakings of contact, as the sound-wave passed each membrane, could thus be recorded on the chronograph. By means of an electrical tuning-fork tracing upon the smoked cylinder, the time could be measured to .00001 of a second.

The experiments were frequently repeated to avoid errors, and it was found that, immediately in the rear of the cannon, the velocity of sound was less than at a distance, but that, going farther and farther from the cannon, the velocity of sound rose to a maximum considerably above the ordinary velocity, and then fell gradually to about the velocity usually perceived.

In order to determine whether the first low velocities were due to the retarding influence of the bodily motion of the air around the cannon, it was pointed at right angles to its first position, when it was found that the maximum velocity came nearer to the cannon. That this apparent retardation was not due to the difference in time of action of the membranes, due to a variation of the force of the wave, is evident both from the slight force required in either case and from the fact that the variation noticed is in the wrong direction.

The conclusions drawn from these experiments are: 1, That the velocity of sound is a function of its intensity; 2, that experiments upon the velocity of sound in which a cannon is used contain an error, probably due to the bodily motion of the air near the cannon.

Evidently a musical sound of low intensity must be used for a correct determination of the velocity of sound.

EFFECT OF THE MOTION OF THE AIR WITHIN AN AUDITORIUM UPON ITS ACOUSTIC QUALITIES. W. W. JAQUES: *Journal of the Franklin Institute*, Dec., 1878.—In this paper is given the account of a series of experiments three in number, made for the purpose of determining the effects of currents of air within an auditorium upon its acoustic qualities.

The first series consisted in laboratory investigation into the effects of currents of air upon a ray of sound, there being interposed between the sound source and the ear of the observer ascending currents of heated air; the sound sources employed were organ-pipes, a violin, drum, flute, and the human voice. Under these conditions there was not only a decided diminution in the intensity of the sound, but also in its clearness, and this latter effect was most marked in the experiments with the human voice, which sounded slightly confused and indistinct, as if each syllable were repeated several times in close succession.

The original ray of sound, striking upon the first current of air, is partially reflected and partially transmitted—the loss of the reflected portion causing a decrease in intensity. The transmitted portion, striking upon a second current, is likewise divided, and its transmitted portion continues to be so divided as many times as there are variations in the density of the air.

Its reflected portion, as well as that of all the succeeding reflections, instead of being wholly lost, is interrupted in its backward course by the first current of air, and reflected along the path of the primary wave, but following it at an interval of time, depending upon the thickness of the current of air. Each reflection being thus again and again reflected and divided, we have, following close upon the primary wave, a multitude of secondary waves, which, falling upon the ear, greatly mask the distinctness of the original sound.

In the second and third series of experiments, made in the hall of the Massachusetts Institute of Technology and in the Baltimore Academy of Music, the laboratory experiments were substantially confirmed, demonstrating the important bearing which the method of warming and ventilation of an auditorium has upon its acoustic properties. Further experiments in the same direction are now in progress.

PHENOMENA OF BINAURAL AUDITION. PROF. SYLVANUS P. THOMPSON: *Philosophical Magazine*, November, 1878.—The series of experiments reported in a previous communication [1] are recapitulated in the present paper, with additional and controlling experiments, for which the Bell telephone was utilized, in investigation of the phenomena of localization, the experiments with the telephone and with tuning-forks being directed to determining how this apparent localization is affected by variations of the sounds in respect of pitch, phase, intensity, and quality, and whether it is to be accounted as a physical, physiological, or psychological phenomenon. To these are added experiments on the binaural estimation of combinational tones. The conclusions derived from the experiments cited are recapitulated as follows:

1. There is an interference in the perception of sound; for two simple tones capable of interfering are still heard to interfere when conducted separately to the two ears.

2. When two simple tones in unison reach the ears in opposite phases, the sensation of the sound is localized at the back of the head.

3. The localization of this acoustic image is independent of the pitch of sounds.

4. When the difference of phase is partial, the sensation is localized partly in the ears and partly at the back of the head.

5. If the difference of phase be complete, but the intensities unequal, the acoustic image, instead of being at the middle of the back of the head, is nearer that ear in which the sound is louder.

6. It is possible to discern the difference between two compound tones which differ only in the phase, but not in the pitch or intensity of their component partial tones. For, when two such compound tones are separately brought to the ears, so that the vibrations of any partial tone present reach the

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[1] Phenomena of Binaural Audition. British Association Reports, Section A. Plymouth, 1877.

ears in opposite phases, that particular partial tone is singled out and localized at the back of the head.

7. When two simple tones are led singly to the ears, no differential tone is heard ; there is some evidence that summational tones are heard.

8. To binaural audition, dissonances are excessively disagreeable, and ordinary consonances harsh.

9. Vibrations mechanically conveyed to a point of the parietal or occipital region of the skull, at one side, are apparently heard in the ear of the other side of the head.

ON THE DETERMINATION OF THE RATE OF VIBRATION OF TUNING-FORKS. LORD RAYLEIGH : *Nature*, Feb. 27, 1879.—This paper, presented by Lord Rayleigh at the meeting of the Royal Society held January 30, 1879, contains a description of experiments made for the purpose of determining the absolute pitch of tuning-forks, by a method proposed by Herbert McLeod, F.C.S., and Lieutenant George Sydenham Clarke, R.E., in a previous paper (Proc. Royal Soc., 1877, XXVI., 162.).

The time-measurer consists of a compensated pendulum, worked by electricity, the impulse given by a driver depending for its action upon gravity alone. The pendulum is arranged to give second contacts, driving a clock-wheel with sixty teeth. This wheel has a platinum pin giving minute contacts, but it is used merely as a switch, the circuit being closed by the pendulum itself.

The tuning-fork apparatus consists of a brass drum, resting on friction-wheels, and driven by a weight and train. Uniformity of motion being of great importance, an air-regulator, consisting of a fan enclosed in the lower compartment of a cylindrical box, is employed. By means of a diaphragm and vanes the fan can be made to do more or less work by pumping air from the cover into the upper compartment. The fan-spindle carries a pulley driven by a thread passing around the drum. Around one end of the drum are wrapped strips of paper on which white equidistant lines have been so ruled that they are parallel to the axis of the drum when the strips are in position. The strip most frequently used has 486 lines around the complete circumference of the drum. Opposite this graduated strip is placed a microscope with its axis horizontal. In the substage is a 2′ objective producing an image of the graduations at the focus of the object-glass of the instrument. At the common focus of the two lenses is placed the tuning-fork, the stem held vertical in a vice. The fork is partially enclosed in a glass case, and is so arranged that the image of one of its limbs seems to cut the image of the graduations at right angles. The fork is set in motion by a suspended double-bass bow. If, when the fork is in vibration, the drum is made to rotate with such a velocity that one of the graduations passes over the interval between two adjacent graduations in the time of one vibration of the fork, a stationary wave is seen of length equal to the length of that interval. To determine the number of vibrations of the fork in a given time it is only necessary, therefore, to count the number of graduations which pass in that period.

An electric counter gives the number of complete vibrations of the drum in any given period, and a fine-pointed tube, containing magenta, is carried by a saddle above the drum, and, being actuated by an electro-magnet, makes a dot upon a piece of white paper wrapped around the drum, at the beginning and end of the experiment. The distance apart of these dots gives the additional fraction of a revolution accomplished by the drum during the period of the experiment. Electric circuits are so arranged that a reverser, turned a few seconds before the minute at which the experiment begins, causes a current to be sent exactly at that minute by the clock relay, which starts the electric counter and also makes a dot on the drum. Just before the expiration of the last minute of the experiment the reverser is turned in the opposite direction, and at the expiration of that minute the counter is stopped, and a second mark made on the drum.

By this means experiments were made to determine the effect of temperature and of continued and intermittent bowing.

INTERMITTENT PERCEPTION OF SOUND TRANSMITTED THROUGH THE CRANIAL BONES. DR. K. BÜRKNER: *Archiv für Ohrenheilkunde*, XIV. Band, zweites Heft, Dec. 18, 1878.—Six cases are reported in which the patients at times were unable to distinguish the ticking of a watch that was pressed against some portion of the skull. In two of these cases the affection was a simple chronic catarrh of the middle ear and Eustachian tube. In a third the patient was suffering in part from a chronic otitis media catarrhalis, and in part from a recent affection of the labyrinth due to a blow upon the head.

In Case I. Dr. Bürkner refers the temporary absence of "bone-conduction" to a marked Eustachian catarrh which produced an increase in the intralabyrinthine pressure. As soon as the Eustachian catarrh had been relieved and the air allowed to pass freely from the naso-pharynx to the tympanum, the pressure upon the labyrinth ceased, and the conduction of delicate sounds through the cranial bones—as, for instance, the ticking of a watch—was restored.

In Case II. the increased pressure upon the labyrinth was probably due, in Bürkner's opinion, to a retraction of the tendon of the tensor tympani muscle. The absence of "bone-conduction" under these circumstances, as remarked by Dr. Bürkner, had already been observed before by Urbantschitsch (Wiener med. Presse, 1875).

In the third case Dr. Bürkner is disposed to attribute the absence of "bone-conduction," not to the traumatic labyrinthine affection, which must have been slight, but to the retracted (sunken) condition of the membrana tympani—that is, to the increased pressure upon the labyrinthine fluid which probably was associated with this condition.

In two of the remaining cases the aural affection was a chronic purulent inflammation of the middle ear, with polypoid granulations in one of them. In both of these cases Dr. Bürkner is disposed to attribute the phenomenon under consideration to some change in the condition of tension of the middle ear apparatus. Thus, in one case, he found that the removal of inspissated pus, which pressed upon the windows of the labyrinth, restored the power to perceive the ticking of a watch that was pressed against the skull at different points. The same explanation would probably hold good, as he believes, for the other case, though here the presence of granulations may have contributed to disturb the equilibrium of the parts.

In the sixth case, adhesions binding down the membrana tympani and ossicles in abnormal positions are blamed for the changed tension of the parts and the resulting unnatural pressure upon the labyrinth. The air-douche, by stretching these false membranes and removing the increased pressure upon the labyrinth, restored—as Bürkner believes—the power of perceiving delicate sounds by "bone-conduction."

In concluding his paper the writer makes the following statement: "In affections of the middle ear the intensity of the perception of sound through the cranial bones, if it be variable in character, is usually proportionate to the distance at which sound can be heard by the same ear through the air."

RAREFACTIONS AND DEFECTS IN THE TEGMEN TYMPANI. BÜRKNER: *Archiv für Ohrenheilkunde*, Vol. XIV., p. 2.—From a further examination of ninety-two skulls in the Göttingen Anatomical Museum, Bürkner is confirmed in his previously stated opinion, that the rarefactions and defects in the tegmen tympani are due to an increase of pressure within the skull. His previous communication was noticed at length in the last number of this journal.

SEQUESTRA IN THE MASTOID PROCESS OF CHILDREN. ARTHUR HARTMANN: *Archiv für Augen- und Ohrenheilkunde*, Vol. VII.—Hartmann's article consists of a careful study of the development of the mastoid cells in the early years of life, and of the influence which this development has on the formation of sequestra, the result of inflammation.

In the new-born child the mastoid process and cells do not exist, but above and behind the tympanum is a triangular air-cavity, from which they are afterwards developed. This cavity, called by Wildermuth the antrum petrosum, gradually enlarges by resorption of the inner surface of its walls, particularly in the direction downward and backward. At the time of birth this antrum petrosum shows signs of being divided into cells by ridges of bone, which are seen on the posterior, upper and exterior surfaces of the cavity. These ridges gradually develop, especially from the external part of the cavity which is formed by the squamous bone, forming an osseous frame-work which finally unites with the ridges from the inner surface of the cavity, dividing the space into cells. From this osseous frame-work other ridges are developed, which by growth gradually still further divide up the cells. At the same time that this process is going on there is an enlargement or rather development of the mastoid process by a true increase in the bone, and the spongy portion of this bone is also metamorphosed by absorption into air-cells. This rarefaction of the spongy portion of the new mastoid process has been heretofore considered the chief element in the formation of the mastoid cells, the cell-walls being the remains of the spongy bone; but Hartmann considers it of secondary importance compared with the true enlargement of the mastoid process and the development of the osseous frame-work just described.

Either of these processes may undergo an arrest of development while the other progresses steadily.

The sutures which unite the squamous and petrous portions of the bone together are of special pathological importance. Through the middle of the roof of the antrum petrosum the sutura petroso-squamosa passes backward till it joins the sutura mastoideo-squamosa, which runs forward to the meatus externus. The latter of the sutures ossifies early and during the first year of life becomes firm, while the former ossifies more slowly and forms for a considerable time a communication between the tympanum and the brain. The older the child, the less likely it is that this communication exists.

Collections of pus in the antrum are exceedingly apt to produce carious destruction or necrosis of the external wall and lead to an abscess beneath the skin. Hartmann thinks this perforation of the bone is more likely to occur in children in the squamous bone rather than through the mastoideo-squamous suture, as was held by Bezold; since this suture ossifies very early, and, having become ossified and offering as firm a resistance as any other portion of the bone, it is more probable that the pus takes the shortest route to the surface, which is through the squamous bone.

The inner portion of the mastoid process is, according to Hartmann, the part from which the sequestra are generally formed in children, and the osseous frame-work which constitutes the divisions between the cells is especially predisposed to necrosis, for during the formation of the cells this part is in very free communication with the tympanum, while in adults the cells only communicate through small openings.

The symptoms, diagnosis, prognosis and treatment are then considered. In regard to prognosis much depends on the constitution of the patient: small sequestra may by disintegration be discharged through the meatus or through a fistulous opening externally; large ones require an operation. While the sequestra remain there is risk of scrofulosis or tuberculosis, extension of inflammation to the brain or large blood-vessels, resorption of pus with resulting pyæmia or septicæmia.

The operation of opening the mastoid process, which Hartmann thinks can be best done by the gouge, is imperative, as without it he considers the disease almost of necessity fatal. He considers it often impossible to say when fatal complications have begun, and yet advises the postponement of the operation till the offensive discharge has continued for some months, in order that the sequestra may be thoroughly separated. In this single statement many surgeons would take issue with him; the remainder of the article, especially in its anatomical features which have been noticed, is of great interest.

DISEASE OF THE MASTOID BONE. W. B. DALBY, F.R.C.S., M.B., CANTAB.: *London Lancet*, Jan. 18, 1879.—Mr. Dalby read a paper on "Diseases of the Mastoid Bone," before the Royal Medical and Chirurgical Society, in which three cases were chosen to illustrate the inflammatory affections to which this bone is liable. In the first case, in which there was no predisposition toward cancer, a local irritation in the tympanic cavity was productive of epithelial growth, which eroded and destroyed the mastoid process, the external meatus, the tympanum, and a large part of the petrous portion. This malignant disease had long been preceded by a discharge from the lining membrane of the tympanic cavity.

In the second case the middle ear had been the seat of acute inflammation for four weeks, and the mastoid cells were opened for the relief of symptoms which were considered to endanger life. Mr. Dalby considered that the operation of opening the mastoid cells is urgently called for when the symptoms point to the presence of pus within the cells; that under certain conditions external evidences, such as superficial tenderness, redness, swelling, and considerable œdema, should not be waited for, and that the fact of the bone being found, after the incision, to be apparently healthy, should not contraindicate the proceeding, which he believed to have frequently been the means of preventing cerebral abscess, meningitis, or pyæmia.

In the third case presented by Mr. Dalby, the whole of the temporal bone of a child was destroyed by ulceration. The subject of the first case died; the subjects of the second and third lived. The specimens of Nos. 1 and 3 were shown.

Mr. Dalby, in referring to the first case, said he would hesitate to decide the pathological question, as to whether it was one of epithelial cancer or rodent ulcer.

A CASE OF MASTOID DISEASE. CHARLES P. KNAPP, M.D.: *Philadelphia Medical Times*, Feb. 15, 1879.—The patient was the wife of a miner. Her age was 23, and she was the mother of one child, which was nursing. For ten months this woman had had occasional ear-ache, and when seen in June, 1878, had severe pain in the right ear and a slight discharge. Her condition was "cachectic," and the membrana tympani is described as being "flabby" in appearance and perforated. She could hear a watch ticking when it was placed over the ear.

A blister was ordered and placed over the mastoid, and bromide of potassium and chloral administered for the relief of the pain.

When the patient was next seen, about two weeks later, there was a profuse discharge from the ear of "greenish-white" pus, and the mastoid region was swollen, red, and very sensitive—indeed, the pain was intense, and hearing was "abolished" on that side.

Wilde's incision was now made over the mastoid process, the tissues being "fully an inch thick." Two drachms of pus were evacuated, and caries of the bone was found to exist.

The progress of the case was regarded as satisfactory until July 26th, when there was a return of the swelling over the mastoid process, a cessation of the discharge, intense pain, and partial paralysis of the seventh pair of nerves on that side. On July 29th, the former opening was enlarged and some bone removed, which left an anfractuosity in the process "over one inch long, and nearly half an inch wide and deep." On July 30th a discharge was re-established, the pain and paralysis relieved, and the patient began to improve. August 6th the doctor was called at night and found the patient delirious and suffering intense pain. The perforation which still existed in the membrane was enlarged with a tenotomy knife, and from this time the patient continued to improve. Nov. 27th the patient called on the doctor, who found the wound healed, and the discharge from the ear absent; she was apparently well and could hear a watch 8 inches. In addition to the treatment mentioned above, the woman was given to take Tr. fer. chlor., and Syr. hypophos. comp. Morphia was also administered when the pain required it. The diet was supporting and the child taken from the breast early in the case.

OTITIS MEDIA PURULENTA CHRONICA. W. OLIVER MOORE, M.D.: *New York Medical and Surgical Brief*, February, 1879. Dr. Moore reports a fatal case of this disease in a machinist aged 50, who three years before had an earache in the right ear, followed by a discharge of pus, which continued up to Sept. 14th, when, after salt-water bathing, there was another attack of earache. On September 15th the right membrane was found to be perforated, the meatus contained pus, and he could not hear the ticking of a watch. The tissues over the mastoid were swollen. An incision three-fourths of an inch in length was made over the mastoid and down to the periosteum; no pus was found; a carbolized tent was inserted into the wound for the purpose of keeping it open.

The patient did not return until the 22d, when there was greater swelling over the mastoid and increased pain. The former incision was freely enlarged, when there was an escape of fetid pus. The bone was soft and carious, and a probe could be passed into the mastoid cells. Up to Nov. 12th the wound was dressed daily, and a large amount of pus discharged from both wound and the meatus externus. The bone was spongy and there was complaint of pain in the head. 15th, less pus from wound and meatus, great pain in the head, loss of appetite, nausea and vomiting; the patient scarcely able to walk; temperature 100°, pulse 78; rational, but lethargic. He was given quinine and potass. iodid. The patient remained in a semi-conscious condition from the 16th to the 18th inst., with very small quantities of pus escaping from the wound and ear. 19th, facial paralysis on right side; marked divergent strabismus, pupils contracted. 20th, comatose at 4 A.M., in which state he died at 8 A.M.

An autopsy was made four hours after death: "Extensive caries was found extending backward and upward from the mastoid process, as far as the parieto-occipital suture; an opening was found through this suture leading into the cavity of the skull, on a level with the lateral sinus. A probe passed in the external opening led directly into the lateral sinus; it (the sinus) was empty, and felt like a fibrous cord; a probe passed through it was arrested just where the lateral joins the jugular vein.

"Meninges very much congested, especially so at the posterior parts. Dura mater adherent at posterior third of longitudinal sinus, a small quantity of lymph between it and cerebral substance.

"In the posterior fossa a layer of pus was found between dura and skull, and the bones eroded and softened. Posterior part of right hemisphere more elevated than opposite side.

"The right lobe of cerebellum contained an abscess about as large as a walnut, situated in the centre of the lobe, the membrane enclosing the abscess was quite thick, appearing like a chronic abscess." It was supposed that, following necrosis of the cranial bones, there was thrombosis of the lateral sinus and abscess of the cerebellum, and subsequently acute meningitis.

In these two cases there were not unusual symptoms pointing to an extension of the inflammation of the middle ear to the cells of the mastoid process, and the great stress which has of late been laid on operative procedures under such circumstances may perhaps be a sufficient reason for hurried surgical interference. It is well known, however, that the tissues in the neighborhood of the ear may become painfully involved without the mastoid cells being especially implicated; and when this is the case, may not a blister over the mastoid, or an incision extending down to the periosteum and kept open by means of a carbolized tent, set up the very inflammation we are hoping to avoid?

Acute purulent inflammation in adults not infrequently extends to the mastoid cells, and becomes exceedingly difficult of management; but comparatively few of these cases result in serious caries and necrosis of the mastoid. When the mastoid process is blistered and incised in doubtful cases, there are certainly chances of aggravating the trouble. In the last case reported, certainly nothing would have been lost by avoiding an immediate operation, for the attack of inflammation induced by the salt-water bathing was essentially the beginning of a new case, such occurrences being not uncommon. Blisters over the mastoid, and even the application of the tincture of iodine, are liable to produce, in acute cases, an irritation of the mastoid cells, and thus invite an extension of the inflammation.

PERSISTENT TINNITUS AURIUM, FOLLOWED BY SYMPTOMS OF CEREBRAL EMBOLISM. SUCCESSFULLY TREATED BY LIGATION OF THE POSTERIOR OCCIPITAL ARTERY. ROBERT REYBURN, M.D.: *National Medical Review*, Washington, D. C., Jan., 1879.—The case of tinnitus aurium here reported was unilateral, and had its origin in an acute inflammation of the internal [?] ear of the left side. When this distressing symptom had continued persistently for fifteen months after every other appreciable sign of his ear trouble, including deafness, had disappeared, the patient himself discovered that, by applying pressure by means of a pad placed over the posterior occipital artery of the affected side, he could control the pulsation of the artery and thereby stop the noises.

An examination at this period discovered a "cirsoid aneurism" or arterial varix of the posterior occipital.

Afterward there occurred suddenly a severe attack characterized by loss of consciousness, vomiting, and an amnesic aphasia (described by Dr. Hammond). This attack Dr. Reyburn diagnosticated to be a case of embolism probably including the distribution of the anterior cerebral artery.

Two months later, when the patient's health had become quite re-established and the tinnitus persisted, the doctor suggested and performed the operation of ligation of the posterior occipital artery, which had the effect of controlling the noises and restoring the patient to a condition of perfect comfort.

EMBOLI IN THE TISSUES OF THE EAR. F. TRAUTMANN: *Archiv für Ohrenheilkunde*, Vol. XIV., Part 2.—Trautmann's paper consists of an account of thirteen careful dissections of the ear in cases of thrombosis. In all of them vegetations of one kind or another were found either in the heart or aorta. Of these thirteen cases four showed emboli in the tissues of the middle ear, in the other nine the ears were free; in seven of the cases emboli were found in the fundus of the eyes, in two the fundus was free, and in four the eyes were not examined. In all of the thirteen cases the inner ear, the arteria basilaris and arteria auditiva were free. In two cases the arteria fossæ sylvii contained emboli.

The source and direction of the arterial vessels supplying the middle and inner ears, Trautmann considers, especially predispose to the entrance of the emboli into the middle rather than the inner ear, for the stylo-mastoid artery—a branch of the posterior auricular—furnishes a more direct communication from the heart to the tympanum, through the external carotid, than the internal auditory artery does from the heart to the labyrinth through the tortuous basilar and vertebral arteries. The tympanic branch of the stylo-mastoid artery supplies the mastoid cells, the posterior part of the tympanic mucous membrane, and the mucous layer of the drum-membrane; and as it was exactly in these parts that the emboli were found, it is evident that they had entered through the stylo-mastoid artery.

The most common cause of embolus in the ear was found to be recent endocarditis either primary and the result of a previous inflammation—the latter more common than the former. In regard to the seat of the endocarditis, in five of the cases it existed in the aorta, in three in the mitral valve, in three in both aorta and mitral valve, in one on both tricuspid and mitral valves, and in one on the mitral and tricuspid valves and also in the aorta. At the seat of the endocarditis small wart-like deposits, consisting of fibrin and micrococci, were found. To the micrococci are referred the specific dangerous character of these deposits.

Trautmann considers that degenerated thrombi in other parts of the body may also lead to the deposition of emboli in the ear, and also that it is not improbable that fat emboli may also occasionally be found in the tissues of the ear.

The gross appearances seen in the middle ear in these cases of emboli were hemorrhagic dots in the mucous layer of the drum-membrane, quite numerous about the manubrium, less common on the periphery of the membrane and on the mucous covering of the body and long process of the incus; they were also occasionally seen in the mucous layer of the pouches of the drum-membrane. The same hemorrhages were also found in the mucous-periosteal lining of the tympanum toward the antrum mastoideum, the posterior part of the promontory, and the floor of the tympanum; occasionally they were also found on the membrane of the fenestra rotunda and along the osseous Eustachian tube; they were also found in the mucous-periosteal lining of the mastoid cells. The hemorrhages were usually about the size of a pin's head, sometimes smaller, and with sharply defined edges. Similar hemorrhagic spots were often found in the tonsils, the tubal prominence, cornea, septum, nasal cartilages and ethmoid cells. In all four of the ears in which these hemorrhages were seen there was also a coagulum of fibrin of variable size and of a yellowish gray-red color, in the tympanic cavity or mastoid cells.

The tympanic mucous membrane, examined microscopically on its surface, showed numerous emboli in its arteries where they divided into branches. The emboli appeared as finely granular masses, and generally, although not always, filled the whole calibre of the vessels. The hemorrhagic spots were effusions of blood into the sub-epithelial and deeper layers of the connective tissue, and in them micrococci could be distinctly made out. In the vessels themselves the micrococci could not be made out with certainty. On the drum-membrane the effusions of blood were chiefly in the mucous layer, but very little being found in the circular and radial layers. Here also micrococci could be seen in the effusions, but not in the vessels.

The cause of the hemorrhages is, according to Trautmann, necrosis of the tissue produced by the micrococci, and also passive congestion. The cause of the coagulum of fibrin is a hemorrhage from the delicate vessels of the mucous membrane.

The disturbances of the functions of the ear produced by these embolic diseases is due not to the hemorrhagic spots, but rather to the coagulated fibrin within the tympanum. These hemorrhagic spots can undoubtedly be made out by inspection during life; and although in themselves they are not fatal, still they are always, Trautmann says, associated with other embolic diseases of other organs, which must make the prognosis eminently discouraging.

TRAUMATIC AFFECTIONS OF THE EAR. DR. F. TRAUTMANN: *Archiv für Ohrenheilkunde*, XIV. Bd., zweites Heft, December 18, 1878.—Three interesting cases of aural disease brought on by violence. In the first of these, the patient, a healthy man, twenty-one years of age, became suddenly quite deaf in the right ear, after a violent fit of coughing. In addition to the deafness, he experienced pains throughout the head, constant tinnitus, and a sensation of numbness in the right side of the face. At first he also noticed slight pains in the affected ear, but these passed away very soon. Examination of the right ear revealed the following condition: Membrana tympani opaque, position of hammer normal, manubrial vessels injected, triangular "bright spot" of normal form. In the anterior half of the membrane four small interstitial hemorrhages are visible, three above the "bright spot," one below it. These hemorrhages, which are about as large as an ordinary pin-head, are round in form, with somewhat irregular edges. A sickle-shaped hemorrhage, 3 mm. long and 1 mm. broad, occupies the posterior superior quadrant, close to the periphery of the membrane. Two small hemorrhagic spots, like pin-points, are also visible in the immediate vicinity of the handle of the hammer, one just below the level of the short process and posterior to it, the other behind and near to the tip of the handle. No evidence was found of a free exudation within the tympanic cavity. By means of a speculum, with magnifying-glass attached to it, the seat of these different hemorrhages was easily ascertained to be between the dermoid layer and the substantia propria of the drum-head. In the course of three weeks the hearing power had become restored to its normal condition; all the other symptoms—the pains in the head, the tinnitus, the sensation of numbness—having disappeared already several days earlier.

In the second case, the patient, a man twenty-two years of age, received a box upon the left ear. Immediately afterward he experienced pretty sharp pain, roaring, and difficulty of hearing in the injured ear. An examination made the next day gave the following results: Left auricle and vicinity normal; no tenderness on pressure. In the posterior half of the membrana tympani, at a distance of 1 mm. from, and running parallel with, the handle of the hammer, a fissure is visible. It extends from a point one millimetre below the level of the short process to the end of the handle of the hammer. In the lower posterior quadrant a coagulum of blood is visible. The lower anterior quadrant is occupied by a moderately large cicatrix, which exhibits a torn condition of its posterior periphery. As the author remarks, cicatrices are very apt to be ruptured by a box on the ear; but the occurrence of a simultaneous rupture of the neighboring healthy membrana tympani may safely be considered as an extremely rare event.

In the third case the patient was struck on the left side of the head with the pole of a hand-cart. The blow caused a wound of the soft parts near the ear, and was accompanied with hemorrhage from the left external auditory canal. There was also some bleeding from the nose, but it lasted only a short time. The patient was carried in an unconscious state to the hospital. The external wound was examined, and found to be of a trivial nature. The bleeding from the ear, however, was so persistent and so copious that it was deemed advisable to plug the meatus. The patient soon recovered consciousness, and exhibited no signs of disturbed sensibility or motility. Two days later the plug of lint was removed from the meatus. The hemorrhage had been entirely arrested, but the lint was found to be saturated with the "liquor cerebrospinalis," which also escaped from the canal when the plug was removed. Two weeks after the occurrence of the accident, Dr. Trautmann examined the patient, and ascertained that he was totally deaf in the left ear. The tones of a vibrating tuning-fork placed upon any part of the cranium were invariably heard by the patient in the right ear, even when the left meatus was plugged with the end of the finger. An examination of the left membrana tympani revealed the existence of a clot of blood resting upon the posterior superior quadrant, and concealing the short process and upper third of the handle of the hammer. After carefully removing the clot, Dr. Trautmann discovered a red zigzag line, marking the course of the rupture which had taken place. Beginning near the umbo, this line ran upward and forward a distance of 3½ mm., close to the short process; from this point it ran directly upward a distance of 2 mm., and then, making a pretty sharp turn, ran backward and upward a distance of 4 mm. No perforation sound was audible, either upon catheterization or when Valsalva's experiment was performed.

At the end of seven months patient was still suffering from dizziness, tinnitus, and difficulty in walking. The desire to move toward the left side was also a noticeable feature in the case. His first efforts to leave the bed and walk about the room invariably brought on a moderately high fever, which then lasted for several days.

During the early part of his illness, while he was confined to his bed, no fever had ever been discovered. Digital examination of the naso-pharyngeal space, even at the end of seven months, caused increased tinnitus and dizziness, showing, as Dr. Trautmann believes, that a complete bony union between the fragments had probably not yet taken place.

In the brief remarks appended to the reports of these three cases, Dr. Trautmann calls attention to the fact that a simple rupture of the membrana tympani, in consequence of a blow, is not accompanied by profuse hemorrhage; that this occurs only when the rupture is associated with a fracture of the posterior upper wall of the osseous meatus.

EXTENSIVE WOUND OF THE AURICLE; SUTURES APPLIED TEN DAYS AFTER THE ACCIDENT; COMPLETE UNION. DR. U. DARTIGOLLES: *Journal de Médecine de Bordeaux*, 28 Décembre, 1878.—The patient, a farmer fifty years of age, got his head jammed in between his wagon, which was heavily laden, and a stone fence. As soon as the man had been released from his painful position, it was found that he was suffering from a wound in the right temporal region, and from an extensive laceration of the right auricle, which was bleeding profusely. The wound of the auricle had almost divided the organ into an upper and a lower half, the latter dangling by a small peduncle attached to the lobule. The physician who was first called to see him brought the edges of the wound together and applied two strips of diachylon plaster to keep them in position. In the course of a few days the patient developed a decided fever, with rapid pulse, coated tongue, and severe headache. When Dr. Dartigolles first saw him, he found the auricle swollen, and covered with blood and pus. The two strips of plaster were still in position, but as soon as they were removed the lower half of the auricle fell down and was left dangling by the narrow fleshy peduncle, thus showing that no effort at union had yet taken place.

On account of the doubtful vitality of the dangling fragment, and of the length of time which had elapsed since the occurrence of the accident, Dr. Dartigolles at first hesitated about the propriety of making any further attempts to secure union between the two halves of the auricle. The serious nature of the deformity, however, rendered it very important that another effort should be made to cause the parts to heal. Dr. Dartigolles accordingly cleaned the parts very carefully, brought the granulating edges together as accurately as possible, introduced four pins, passing them through the skin and cartilaginous framework, and then applied thread to the pins in the form of a figure 8. Frequent applications of compresses soaked with Labarraque's solution were ordered to be made. On the fourth day the fever and headache had disappeared. On the eighth day a small portion of the helix, which had become gangrenous, separated, and two of the pins were removed; they were immediately replaced, however, as it was found that no adequate union had yet taken place. On the sixteenth day solid union was found to have taken place, and all the pins were removed. At the point where gangrene had destroyed a portion of the helix a small ulceration still remained; otherwise the process of healing was perfect.

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NOTES.

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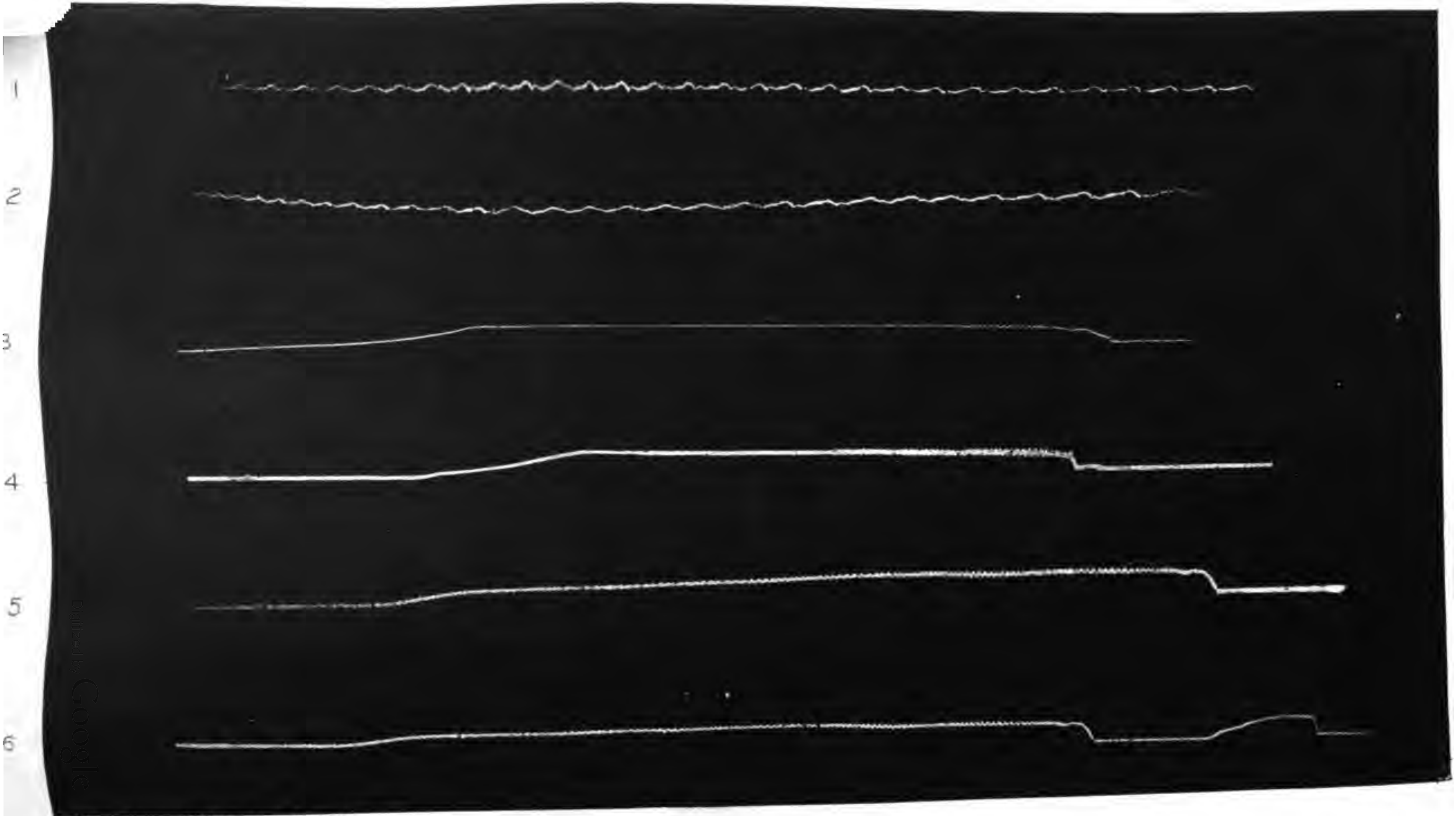
The subscriptions to this journal have been so largely in excess of the expectations of the editors and publishers, that the January number has been entirely exhausted. Those, therefore, who possess copies of this number, and who do not care to keep them, will confer a favor by returning them to the publishers.

The Bibliographical Index is intended to include books and papers published during the three months next but one preceding each quarterly issue of the Journal. In the present number, however, previous publications of importance have been included. In the preparation and revision of the present Index, the Index Medicus edited by Dr. J. S. Billings, U.S.A., has been of great assistance.

Dr. J. Patterson Cassells, Glasgow, has undertaken the authorized translation into English of Politzer's Lehrbuch der Ohrenheilkunde.

The Archives of Ophthalmology and Otology, hitherto published by William Wood & Co., are soon to appear in the form of two separate journals—the Archives of Ophthalmology and the Archives of Otology, the latter journal being edited conjointly by Prof. Moos, of Heidelberg, and Drs. D. B. St. John Roosa and H. Knapp, of New York. The first number will probably be issued early in the summer. G. P. Putnam's Sons, of New York, are to be the publishers of both journals.



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THE OUTER EAR OF BLARINA BREVICAUDA.

BY DR. ELLIOTT COUES, U.S.A..

THIS animal has sometimes been described as having no external ear, and even named technically ("Anotus") from this alleged circumstance; but the orifice of the external meatus is extremely large, and the folds of skin which constitute an auricle are prominent and of remarkably complicated structure. Though the presence of a large auricle is now known, I have seen no sufficient description of its structure. On viewing the parts when the fur is undisturbed, no ear whatever appears, because the flap of integument is folded so closely forward as to lie quite smoothly, completely closing the meatus like a valve, and showing only its back surface, which is as densely hairy as the rest of the integument about the ear. But, on pushing or blowing the fur aside, and opening up the parts, the orifice gapes widely; its longest diameter is a fourth, if not three-tenths, of an inch in extent; it is oblique in general direction, upward and backward; the general cavity seems naked, but is really beset with numberless colorless hairs, so minute as to be invisible except under the lens. In advance of this closely pilous surface is a somewhat crescentic margin of absolutely naked skin, with the outer border of which latter the common furry integument of the head is continuous, without a trace of a raised rim. This naked crescentic strip is that against which the border of the flap of the ear is applied, fitting closely. At the back of the pilous surface certain folds of naked integument rise to meet the attached base of the auricle, and another such fold curves around the true orifice of the meatus externus, circumscribing this aperture posteriorly. Anteriorly it is circumscribed still more conspicuously by a fold of the common integument. The meatus itself is a nearly circular opening, at least a tenth of an inch in diameter, situate at the bottom of the general cavity I am describing. All the parts thus far noted are independent of the valvular auricle. This flap consists of three portions. Externally and posteriorly it is a long, loose fold of the common integument, with convex free border, densely furry externally, and completely circumscribing the general orifice; above, it sinks into the general integument; below, it is continuous with the fold of integument which circumscribes the orifice of the true meatus, a slight notch separating them, like the notch above the lobule of the human ear. This general exterior fold is the true helix. Attached to the inner naked surface of the helix are two prominent folds. One comes vertically down, from the point above where the helix sinks into common integument, to below the middle of the helix, where it is attached; it looks like a secondary helix inside the main one; it is obviously the anti-helix. Its free border is fringed with long hairs. The other one of the two prominent folds is an anti-tragus, which rises vertically from the lower margin of the helix, just behind the notch above mentioned, and then curves inward to subside in the anti-helix; its free border is fringed, like the anti-helix, with long hairs; the structure is as prominent as in some bats. The parts are very difficult of concise verbal description in terms producing a mental picture of their structure and arrangement. But it will be seen that the animal, so far from being "anotous," or even "cryptotous," has a very large, open meatus externus and a highly developed, complicated auricle or pinna, in which helix, anti-helix, and anti-tragus are prominent—in which, in short, the principal parts of the human ear may be fully recognized, excepting the lobule. The point is simply that these parts are hidden in life by the adpressed pinna, which is directed forward to cover in the whole arrangement, and which, being furry on the posterior (now become external) surface, looks like the rest of the integument. If one will simply fold his own ear closely forward, and imagine the lobule absent, he will have a fair idea of the relations of the parts, though they are much larger and better defined in this shrew than in the human species.

VOWEL THEORIES.

By ALEXANDER GRAHAM BELL.

(Read before the National Academy of Arts and Sciences, April 15, 1879.)

Helmholtz has shown that an educated ear perceives a combination of musical tones where an uneducated ear supposes a single sound; and his theory, that those feeble, usually unheard musical tones are the cause of the peculiar sensation we term the "quality" of a sound, seems now to be universally accepted as correct.

According to this theory, a vowel is a musical compound, consisting of a mixture of musical tones of different pitches and various intensities. The lowest, or fundamental tone, gives the pitch to the whole, and is determined by the rate of vibration of the vocal cords.

It is certainly the case that an attentive ear can perceive, in every vowel uttered, a number of distinct musical sounds; but the hypothesis that the ear perceives them *only*, and that it is unable to appreciate the quality of the vowel directly, should be received with caution. According to Helmholtz, the human ear is incapable of perceiving any other than simple pendular vibrations, and it is therefore under the necessity of splitting up a vowel into its constituent musical elements before it can perceive its quality.

Thus Helmholtz holds that vowels are *inferred* from the presence of certain musical tones, and that they do not give rise in the ear to distinct sensations of their own.

The rods of Corti are supposed by him to analyze the vibrations imparted to the liquid of the internal ear, so as to split them up into the pendular motions of which they are theoretically composed; but it cannot be received as proven that the simultaneous vibration of certain of these rods gives rise to the perception of the quality of a sound; for Pritchard and other comparative anatomists have shown that the rods of Corti are entirely wanting in parrots and other birds that imitate and therefore perceive the sounds of speech.

Whether or not, however, there exists in the human ear an apparatus for taking direct cognizance of the quality of a sound, Helmholtz has proved, by the synthesis of vowel sounds, that there exists the most intimate relation between certain combinations of musical tones and the quality of a sound. Not only are such tones audible whenever a vowel is produced, but the converse is equally true; and we may therefore assume, at least as a working hypothesis, that vowels are compound musical tones. I shall follow the example of Ellis[1] in terming the musical constituents of vowel sounds, "partial" tones, to designate their subordination to the compound as a whole.

The illustrations of vowel-synthesis given by Helmholtz show vowels composed of tones whose frequencies are multiples of the fundamental; and the question arises: "*Are the upper partial tones, which are characteristic of vowel sounds, invariably harmonics of the fundamental of the voice, or are they independent of it?*"

Again: "*If they are harmonics, do they uniformly bear the same relation to the fundamental, whatever the pitch of the voice may be?*"

These questions at first sight seem to receive different answers, accordingly as we attempt to solve the problem (1) from a consideration of the organic formation of the vowel sounds, or from an examination of the records, (2) of the phonautograph, and (3) of the phonograph. The results common to all three methods of investigation, however, point to a theory of vowel sounds in close accordance with the ideas of Helmholtz, as expressed by Ellis in his "Early English Pronunciation," Part IV., p. 1277.

In examining these questions, it may be convenient to designate, by distinct names, two varieties of Helmholtz's vowel theory, concerning which there has been of late considerable discussion:

The fixed pitch hypothesis.—The upper partial tones characteristic of vowel sounds may be supposed to have fixed, invariable pitches, and the element of pitch may be considered the distinguishing feature.

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[1] The phraseology of Ellis will be used throughout this paper. For definitions, etc., see Ellis's translation, "The Sensations of Tone," footnote to page 86.

The harmonic hypothesis.—According to this hypothesis, the upper partial tones characteristic of vowels are always harmonics of the fundamental, varying in pitch with it, the vowel characteristic lying in the predominance of certain harmonics.

As an illustration of the difference between these hypotheses, let us consider for a moment the musical composition of the vowel ō.

Helmholtz states that he produced a very fine ō by combining the sounds of certain tuning-forks whose rates of vibration were multiples of that of the lowest fork. The prime tone was B_b; the 2d, 3d, and 5th forks were allowed to sound feebly, and the sound of the 4th fork was brought out much more strongly. In this experiment, then, the characteristic tone (b'_b) was the double octave of the fundamental. Now, if the fixed pitch hypothesis be correct, the vowel ō should always be distinguished by a partial tone of the pitch (b'_b); whereas, if the harmonic hypothesis be correct, the predominant partial should vary in pitch with the pitch of the voice, and be always its double octave.

I. *Vowel Theories, considered in Relation to the Organic Formation of Vowel Sounds.*[1]

When we examine the vocal organs we find numerous cavities located in the thorax, larynx, pharynx, nares, and in the mouth. The air in each cavity has a tendency towards a definite rate of vibration, and when agitated in any way produces its resonance tone.

In the act of speech the air is set in vibration in all these cavities, the resonance tones of the cavities mingle with the tones due to the vibration of the vocal cords, and thus produce the complex sounds of human speech. The movements of the tongue, lips, etc., modify the shape and size of some of these resonance cavities, and thus enable us to produce sounds the musical constituents of which are almost infinitely variable at will. The constant cavities of the vocal organs, the shapes of which are determined by nature, and are therefore independent of will, probably give to the speaker's voice that individuality of tone that enables us to pick out the voice of one speaker from a multitude of others, while the variable cavities give prominence to partials that characterize the elements of spoken language.

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[1] **In all references to the organic formation of speech sounds, I adopt the phraseology of Melville Bell. For definitions, etc., see "Visible Speech: The Science of Universal Alphabetics."**

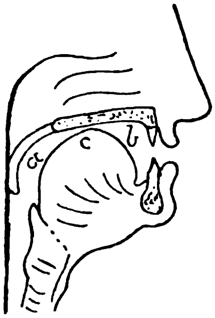

Fig. 1.

The cavities of the mouth are chiefly concerned in the production of vowel quality. When. a vowel position is assumed by the vocal organs, the mouth-passage is slightly constricted at some particular part (see Fig. 1), and thus two resonance cavities, *a* and *b*, are established, the interior of the mouth somewhat resembling in shape the interior of a chamber formed by placing two bottles neck to neck, the two resonance chambers being represented by the bodies of the bottles, and the constricted passage between them by the necks.

I have found that the resonance tones of these cavities can be readily studied in the following manner:

To Study the Pitch of the Posterior Cavity:

Close the glottis, assume the vowel position, and tap gently against the throat with the thumb-nail. (A sound will be perceived somewhat similar to that produced by tapping against the side of an empty bottle.) A double pitch will be noticed, but the tone due to the posterior cavity, *a*, will be much more fully produced than that due to the other. I have succeeded in making the sound audible to large audiences by placing the forefinger of the left hand against the throat, and tapping it very forcibly with the thumb-nail of the right hand. A loud sound can also be produced by striking a piece of wood or cork held against the throat.

To Study the Pitch of the Anterior Cavity:

Close the glottis, assume the vowel position, and strike gently a piece of wood, or cork, held in front of the mouth or against the cheek. I have found that an ordinary lead-pencil, held firmly against one side of the mouth, readily yields the resonance tone of the mouth cavity when struck with the thumb-nail. A double tone can be perceived, but that due to the anterior cavity is much more prominent than the other.

The tone due to the anterior cavity may be studied alone, by depressing the soft palate until it touches the back of the tongue. (This is the position for "ng" in the word "sing.") Under such circumstances the soft palate cuts off all communication with the air in the posterior cavity, and a single resonance accompanies each vowel position. When the absolute pitch of the anterior cavity is sought, the former method is preferable, as the depression of the soft palate alters the tone.

The tones of the cavities are best brought out by contrast. For instance, assume successively the positions for certain vowels, and observe the series of tones produced, first by the anterior cavity and then by the posterior cavity. The differences will be found to be very striking.

When the vowel positions are assumed in the order shown by Melville Bell, in his "Visible Speech," the tones of the cavities are found to be arranged in regular musical sequence. For instance, commencing with the high-front vowel (ee), assume successively the positions for the other vowels of the front group. A double series of resonances will be obtained, so arranged that the tones of one series fall in pitch while the tones of the other rise. *The same remark is true for all the organic groups of unrounded vowels. The pitch of the anterior cavity falls in pitch as the vowel aperture is enlarged, and that of the posterior cavity rises.* It is different, however, with rounded vowels. For instance, take the high-front-round vowel (ü in German), and assume successively the positions for all the vowels of that group down to the low-front-wide-round vowel. *The resonance tones of the anterior and posterior cavities both rise in pitch as the vowel aperture is enlarged. All the groups of rounded vowels behave in a similar manner.*

Again, compare unrounded vowels of similar aperture, but of different organic formations. For instance, assume successively the high-front, high-mixed, and high-back vowel positions: the pitch of the anterior cavity falls and the pitch of the posterior rises. The same thing occurs when we compare the mid-front, mid-mixed, and mid-back vowels, or the low-front, low-mixed, and low-back vowels.

Comparing in like manner rounded vowels of similar aperture, but of different organic formation, the same fact is noticed, namely, that *the further back in the mouth the point of constriction is located, the lower is the pitch of the anterior cavity and the higher the pitch of the posterior.*

Comparing rounded and unrounded vowels of the same organic formation and aperture, as, for instance, the high-front vowel (ēē) with the high-front-round vowel (ü in German): the pitch of the posterior cavity is the same for both vowels; but the pitch of the anterior is lower for the rounded (ü) than for the unrounded vowel (ee).

The changes of pitch produced in the anterior and posterior cavities of the mouth become intelligible by reference to familiar facts of resonance. Thus blow across the mouth of an empty bottle, and its resonance tone can be perceived in the rustling sound caused by the breath. Pour water into the bottle, and the pitch of the tone becomes higher. Place your fingers over the mouth of the bottle, so as to reduce the size of the opening, and the pitch falls.

It will thus be seen that the pitch of a cavity falls when its interior capacity is increased, and also when the exterior orifice is contracted.

The depression of the tongue (see Fig. 1) should, therefore, cause an elevation of the pitch of cavity *a*, and a lowering of that of cavity *b*; for the air space in cavity *b* becomes larger when the tongue is depressed; and the width of the exterior opening (*c*) of cavity *a* is at the same time increased.

Every position assumed by the vocal organs determines the shape and size of the cavities of the mouth, and thus determines the absolute pitch of the resonance tones proper to those cavities.

When air is passed through the mouth, as in the act of speech, a new element enters into the inquiry: Is vowel quality due to the mouth position assumed by the organs, or is it caused by the vibration of the vocal cords? If the former, we would expect that the characteristic upper partials would bear some relation to the resonance tones proper to the mouth cavities and be independent of the pitch of the voice. If the latter, we would expect them to bear some relation to the pitch of the voice and be independent of the pitch of the mouth cavities.

The mere passage of air through the mouth is sufficient to bring out the characteristic tones of the mouth-cavities. Vowel quality is audible in a whisper, and can even be produced by forcing air into the mouth by means of a pair of bellows.

It should be noted, in this connection, that vowels are generally preceded in actual utterance by elements that approximate very closely to consonants in their organic formation; "initial vowels" being preceded by the throat-shut consonant—an element belonging to the same general class as P—T—K, but for which we have no letter in the English language.

Consonants result from obstructive positions of the vocal organs. During the utterance of speech the air in the thorax is continually compressed by the action of the abdominal muscles, diaphragm, and muscles of the thorax, so that when the emission of breath is momentarily checked by the formation of some obstructive position, the cavities behind the point of constriction become inflated.

Thus, when a vowel is preceded by a consonant—a sudden puff of air accompanies the relinquishment of the consonantal position —and this puff, passing through the vowel-configuration, is sufficient to bring out the characteristic tones of one or more of the vowel-cavities quite independently of the vibration of the vocal cords.

An interesting case may be mentioned which bears upon this point. Dr. Moore, of Rochester, N. Y., had a patient whose glottis had become closed by disease. For twenty-five years the man had been dependent for life upon air supplied through a tube inserted in the *trachea*. He could speak, although no particle of air could be forced into the mouth from the lungs. His speech was perfectly intelligible, distinct and even loud, but of course peculiar, on account of the absence of voice. He could not pronounce vowel sounds by themselves, but they were distinctly audible when preceded by consonants. By long practice the man had acquired the power of contracting and expanding the cavity at the back part of the mouth to a wonderful extent. The air which was moulded into speech was alternately drawn into this cavity and expelled from it by the forcible action of the muscles of the pharynx, soft palate, and back part of the tongue. The cavity seemed to be continually in a state of change—alternately expanding and contracting during the whole progress of his articulation—so that the man could speak for any length of time without pausing for breath! There seemed, however, to be an instinctive remembrance of the connection between breathing and speech, for he was in the habit of expelling air through the tracheal tube while he was speaking, and of remaining silent when he drew air into the lungs.

Another curious case has been made public by Dr. Moore[1] A patient had attempted suicide by cutting his throat. The epiglottis was severed from the larynx, and, when the man attempted to articulate with his head thrown back, the air passed out through the opening in his throat instead of through the mouth. Under these circumstances the man could pronounce intelligibly certain vowel sounds. Dr. Moore satisfied himself and other observers that there was no passage of air through the mouth, by artificially closing the aperture between the epiglottis and back of the pharynx.

Dr. Moore argued from this experiment that the vowels heard were produced in the larynx instead of in the mouth. This position, however, seems to be untenable; for the mouth positions for these vowels might have been assumed during the production of the sounds, and the tones of the mouth cavities would be brought out by sympathetic resonance without the necessity of passing air directly through the mouth.

In whistling, the resonance tone of the anterior cavity is brought out so loudly as to constitute a clearly recognizable musical tone. A careful observer will find that his tongue assumes a definite position for each note whistled, and a person can be made to whistle an air unintentionally by making him attempt to whistle certain vowels in succession. In whistling, it seems necessary that the constricted passage in the mouth should be much more narrowed than in actual articulation, and that the anterior orifice should also be small.

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[1] See Trans. N. Y. State Medical Society for 1872.

Sing such a vowel as ō and gradually contract the passage between the back of the tongue and the soft palate. The resonance tone of ō will be observed to grow in intensity as the passage is contracted, until finally the vowel is converted into a vocalized whistle. By labializing the various vowel positions, the resonance tone of the anterior cavity can be brought into great prominence, and a whistle produced of definite fixed pitch for each vowel-position.

It is found that the pitch of the voice can be varied without appreciably affecting the pitch of the vowel-whistle. It is certainly difficult to bring out the whistle of ōō or ō upon certain pitches of the voice, but the high-front and high-mixed vowels labialized can be easily retained in a whistling condition while the voice glides upwards or downwards.

In studying the double resonance of the mouth-cavity, I have been led to the belief that the fundamental of the anterior cavity is much more essential to the production of vowel quality than that of the posterior.

If we prolong the sound of the voice, and study the effect of the movement of the different vocal organs in modifying the quality of the resultant sound, the attention will be arrested by the fact that movements of the organs farther forward than the back of the tongue produce changes of vowel quality, but that motions of the parts behind the back of the tongue do not. The motions of such parts produce quite as marked, if not *more* marked, changes of quality than in the former case; but the resultant sounds would not ordinarily be designated as vowel variations. We should rather speak of them as changes in the *quality* of the voice. For instance, the depression of the soft palate produces a nasal effect, and the movement of the base of the tongue towards the back of the pharynx produces a "guttural" quality of voice.

If the passage between the base of the tongue and the back of the pharynx be contracted laterally, by approximation of the posterior pillars of the soft palate (shown by dotted lines in Fig. 2), a very curious change of quality is produced. The voice acquires a metallic ring, somewhat like the tone of a brass wind instrument. When the posterior pillars of the soft palate approximate so closely as almost to touch, a very disagreeable reedy quality of voice results, which can perhaps be best described as a sort of "Punch-and-Judy" effect.

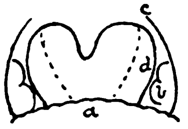

FIG. 2.

When these various motions are produced while a vowel position is assumed, the pitch of the posterior vowel cavity is affected, and the quality of voice accompanying the vowel is changed, but not the vowel itself.

From this it seems evident that the anterior cavity is more important in determining the vowel quality than the posterior cavity.

An examination of the mechanism of speech leaves the mind decidedly biased in favor of the fixed pitch theory of vowel sounds.

II. *Vowel Theories, considered in the Light of Experiments with the Phonautograph.*

If the harmonic hypothesis be correct, and vowels are composed of partial tones whose frequencies are multiples of that of the fundamental of the voice, we should expect, from the researches of Fourier, that the tracings obtained from the phonautograph for vowel sounds should be invariably periodic curves, whatever the pitch of the voice might be. Whereas, if the fixed pitch hypothesis be correct, vowels should not yield periodic curves when tones of voice are used which do not contain the fundamentals of the mouth cavities amongst their harmonics.

Furthermore, if the harmonic theory be correct, the predominant partial tones, bearing always a fixed ratio to the fundamental in pitch and loudness, should produce for each vowel sound a definite form or forms of curve, which should be constant for the same vowels under different pitches of the voice.

Early in 1874 I carried on a series of experiments with an improved form of phonautograph devised by Mr. Charles A. Morey, of the Institute of Technology, in Boston. Vowel sounds were sung to various pitches, and their tracings preserved for study and comparison. The results were briefly as follows:

1. Vowel sounds uniformly produced periodic curves, whatever pitch of voice was employed.
2. The form of vibration was not a constant characteristic.
3. Different vowels sung to different pitches often seem to produce similar curves.
4. Different vowels sung to the same pitch traced curves of different shapes, but they were not sufficiently marked to enable the vowels to be certainly identified.
5. There seemed to be a relation between the complexity of the tracing and the vowel aperture; close aperture vowels yielding curves that approximated very closely to simple pendular vibrations.

Thinking that the results obtained with Mr. Morey's phonautograph might be influenced by the imperfection of the apparatus employed, I tried the tympanic membrane of a human ear as a phonautograph. Dr. Clarence J. Blake, of Boston, suggested this idea, and kindly prepared a specimen for me, with which I carried on experiments. The tympanic membrane and the ossicula were moistened with glycerine and water, and a stylus of hay attached to the incus enabled me to obtain tracings of vowel vibrations on sheets of smoked glass passed rapidly underneath. The results obtained with this apparatus were similar to those obtained with Mr. Morey's phonautograph, and I found it impossible to recognize the various vowel sounds by their tracings. I do not know the full results obtained by Prof. Eli W. Blake with his photographic phonautograph, but all the vowel curves drawn by him, that I have seen, were periodic curves, and seemed to support the conclusions noted above. The general indications of all forms of phonautograph seem to favor the harmonic hypothesis much more than the other. The unstable character of the vibration-forms might be explained by supposing the phases of the harmonic partials to have varied at different times; for Helmholtz has shown that the phases of the upper partial tones are immaterial to the perception of vowel quality.

III. *Vowel Theories considered in the Light of Recent Experiments with the Phonograph.*

Mr. Edison's phonograph furnishes us with an instrument which fortunately can be utilized in the solution of acoustical problems that had before seemed insoluble by experimental methods. I believe that this instrument can be employed as a means of ascertaining the truth or falsity of the harmonic hypothesis.

If the differences of vibration-forms obtained by the phonautograph for the same vowel, at different pitches, merely indicated a difference of phase of the upper partials—the same harmonics being predominant at each pitch of the voice—then, if the relative phases of the harmonic partials could be retained when the pitch of the voice was changed, the same vowel at different pitches should be characterized by the same curve; and a vibration of uniform shape impressed upon the tinfoil of the phonograph should produce the same quality of vowel, whatever the speed of rotation of the cylinder might be.

If, on the other hand, my observations with the phonautograph were correct, that different vowels could be found, which, when sung to different pitches, produced the same tracing, then a vowel sung to the phonograph, while the cylinder is turned at a certain rate of speed, should be reproduced by the instrument as a different vowel when the speed was changed.

When Mr. Preece exhibited the phonograph before the Physical Society of London, on the 2d of March, 1878, I suggested that this experiment should be tried, and stated my belief that the quality as well as the pitch of a vowel would be affected by the speed at which the cylinder was turned. The experiment was at once made, and the results were apparently as I had anticipated. (See *Nature*, Vol. XVII., p. 415.)

Prof. Fleeming Jenkin and Prof. J. A. Ewing about the same time performed a similar experiment in Edinburgh, but arrived at quite different results. They stated, in a letter, dated March 11th, 1878, that " the pitch is, of course, altered, but the vowel sounds retain their quality when the barrel of the phonograph is turned at very different rates. We have made this experiment at speeds varying from about three to one, and we can detect no alteration in the quality of the sounds." (See *Nature*, Vol. XVII., p. 384.)

Such a result determined me to repeat the experiment carefully and at leisure. Mr. Stroh, the eminent mechanician of Hampstead Road, London, kindly permitted me to use his automatic phonograph, the cylinder of which was moved by clock-work. Mr. Alexander J. Ellis was present, and assisted during the experiments.

We found it extremely difficult to use the phonograph in the observation of minute phonetical distinctions. While we differed in our appreciation of some of the effects produced, we agreed in thinking that vowel quality was affected to some extent by the speed of rotation; but we were unable to determine either the amount or the nature of the change. Among other results of these experiments, the vowels in the words mēan, māne, mĕn were often reproduced to my ear as approximately the vowels in mōon, mōan, mŏrn; the reproduced ēē sounding to me as an extremely faint ōō. Mr. Ellis, however, could not agree with me in this conclusion, although he admitted that the quality of these vowels was changed in the reproduction.

The results of our experiments were communicated to *Nature* by Mr. Ellis, in a letter, dated the 3d of April, 1878. (See Vol. XVII., p. 485.)

Dr. Clarence J. Blake, of Boston, and Prof. Cross, of the Institute of Technology, in the same city, were as much struck as I had been by the statements made by Fleeming Jenkin and J. A. Ewing concerning the fixity of vowel quality under varying speeds of rotation, and repeated the experiments alluded to. Very striking differences of vowel quality were perceived by them. Prof. Cross communicated the results to *Nature*, in a letter, dated Boston, April 29th, 1878. (See Vol. XVIII., p. 93.)

This called forth a response from Edinburgh, dated May 29th, 1878. Fleeming Jenkin and J. A. Ewing modified their former statements concerning the fixity of vowel quality, but stated that "the five vowels *a*, *e*, *i*, *o*, *u* (Italian), pronounced in succession, are, by contrast at least, thoroughly distinguishable when the instrument is run at various speeds, such as to reproduce the sounds at all the pitches within the compass of the average human voice.

That no marked change is produced in the relative values of the vowels is confirmed by the fact that neither in public nor private exhibitions do the hearers of sentences, alternately run slow and fast, suggest that the vowels have changed with a change of speed. . . . We do not, however, think that our instrument speaks with sufficient distinctness to warrant our expressing an opinion as to the constancy of quality of any single vowel when the instrument is run at various speeds." (See *Nature*, Vol. XVIII., p. 167.)

Since the publication of this letter no notice seems to have been taken of this most interesting subject until quite recently, when Mr. Preece and Mr. Stroh revived the discussion in *The Electrician*, for March 29, 1879. Amongst other results they observed that the vowel *āh* is converted by a slow rotation into ō, and that the converse is equally true. This fact has also been independently discovered in America by Mr. Francis Blake and myself.

I have at various times, during the past few months, made experiments with phonographs of different kinds to determine the question of vowel change or fixity; and all the instruments have answered the question of vowel fixity, under changing speeds of rotation, in the negative.

Some experiments made by Mr. Francis Blake and myself, on the fifteenth day of March, 1879, not only demonstrated that vowel quality *does* change under varying speeds of rotation of the cylinder of the phonograph, but also manifested the direction and nature of the change.

The ordinary mode of conducting the experiment previously, was as follows:

A vowel was sung to the phonograph while the cylinder was turned at a uniform rate of speed. The sound was then reproduced from the instrument, while the barrel was turned at a uniform, but different rate of speed. When the experiment was conducted in this way, the change of vowel quality was not marked, and very uncertain results were obtained.

The experiment was now varied as follows:

A vowel was sung into the phonograph in a high-pitched voice, while the cylinder was turned at a uniform but high rate of speed. When the sound was reproduced, the cylinder was started at a high rate of speed and allowed to come gradually to rest. At once the nature of the vowel change became manifest. The vowel *āh* changed by insensible degrees to *awe*, *oh*, and finally *ōō*. (The same effect can be produced by gradually contracting and "rounding" the orifice between the lips, while at the same time the back of the tongue is slightly raised.)

The vowel ēē was gradually converted into the German vowel ü. I am perfectly sure of the labial element of this change, but am uncertain whether there was not also a change in the lingual element. The reproduction was very faint, but to my ear the vowel finally produced was either the "high-front-round" or the "high-mixed-round" vowel.

The diphthongal vowel ī long was reproduced approximately as "ow" in "now." The exact reproduction seemed to be as follows: The initial sound was the "low-back-wide-round" vowel, gliding finally to "high-mixed-round."

A long series of experiments with various vowels satisfied us that the reduction of the speed of rotation below the original rate at which the cylinder was turned, occasions an effect analogous to that produced by labializing the original sound.

It was also evident that there was a lingual element of change, especially when vowels of the "front" and "mixed" series were tried; but it was extremely difficult to locate the resultant sounds. The fixed pitch hypothesis offers a clear understanding of the nature of the change.

With decreasing speed of rotation, the prime tone and the characteristeric upper partials fall simultaneously in pitch. Upon our theory the characteristic partials correspond to the fundamental of the cavities formed in the mouth by assuming some position of the vocal organs. Hence we might expect that as the speed of rotation decreased, the sound produced would correspond to a vowel having anterior and posterior cavities of lower pitch than the original one.

The pitch of the anterior cavity can be lowered by gradually approximating and rounding the lips, and the pitch of the posterior cavity can be similarly changed by contracting the passage between the two cavities. The change of vowel quality produced by decreasing the speed of rotation of the cylinder of the phonograph thus seems to correspond to the change produced by gradually elevating the tongue in the mouth and at the same time contracting and rounding the orifice between the lips.

Effect of Increasing the Speed of Rotation.

A vowel was sung into the phonograph, in a low-pitched voice, while the cylinder was turned very slowly. When the sound was reproduced, the cylinder was started slowly, and the rate of rotation gradually increased.

The vowel *āh* changed gradually to ā in ask, and then to ă (in the word măn). This change of vowel effect was accompanied by a remarkable change in the quality of the reproduced voice. The sound was accompanied by a metallic twang. This disagreeable quality became more and more marked as the speed of rotation was increased, until a sort of " Punch and Judy " squeak was produced.

Upon the fixed pitch hypothesis this change also becomes intelligible.

Organically considered, the change corresponds to a gradual contraction of the posterior cavity, accomplished by approximation of the posterior pillars of the soft palate (as in Fig. 2), accompanied by a gliding forward of the lingual position. This is exactly what one would expect upon the supposition that the posterior and anterior cavities were of higher pitch than in the original vowel.

I was surprised at first that I could detect no tendency in ā (in aim) or ĕ (in mĕn) to glide upwards towards ēē (in sĕĕ), for the anterior cavity in ēē is of smaller size and higher pitch than in the other vowels mentioned; but I now see that the elevation of the tongue would tend to lower the pitch of the posterior cavity, which should theoretically be raised simultaneously with the elevation of the pitch of the anterior cavity.

Results obtained by Fleeming Jenkin and J. A. Ewing.

Jenkin and Ewing have made a minute analysis of the records impressed upon the tinfoil of the phonograph by vowel sounds, and have published the results of their researches in the columns of

Nature, and in the Transactions of the Edinburgh Royal Society for 1878.

Their analysis of the records of the vowel ō brought out the fact that, whatever pitch of voice was employed, the predominant partial was b'_b, as fixed by Helmholtz, or within a few notes of that pitch.

As the final result of their researches, Jenkin and J. A. Ewing say (see *Nature*, Vol. XVIII., p. 455): "We are thus brought back to our original statement, that in distinguishing vowels the ear is aided by two factors—one depending on the harmony or group of partials, and the other on the absolute pitch of the constituents. . . . . We are forced to the conclusion, already adopted by Helmholtz and Donders, that the ear recognizes the kind of cavity by which the reinforcement is produced; that, although the sounds which issue differ so much that we fail, when they are graphically represented and mathematically analyzed, to grasp any one prominent common feature, nevertheless, by long practice, the ear is able to distinguish between the different sorts of cavities which are formed in pronouncing given vowels."

General Results.

Of the two hypotheses with which we started, it is certain that one (the harmonic) is wrong and the other only partly right. The balance of evidence inclines largely towards the fixed pitch hypothesis, the main argument against it being found in the periodic curves of the phonautograph.

The solution of the difficulty seems to be that suggested by Ellis, namely, that, "what we call our vowels are not individuals, scarcely species, but rather genera, existing roughly in the speaker's intention, but at present mainly artificially constituted by the habits of writing and reading." (See "Early English Pronunciation," Part IV., p. 1279.)

I do not doubt that the distinguishing characteristic of the vowel-individual, if we could examine it critically, would be found to consist in the presence of partial tones of fixed pitch corresponding to the resonance cavities of some definite fixed position of the vocal organs. A resonance cavity, however, is found to be capable of reinforcing not only a tone corresponding to its fundamental or proper tone, but other tones that differ slightly in pitch from that.

The reinforcement is greater or less as the exciting tone is more or less removed in pitch from the proper tone of the cavity. Thus, when a vowel is sung or spoken, those harmonics of the voice which are nearest in pitch to the proper tones of the mouth cavities would be reinforced at the expense of the proper tones themselves. And although the ear may be guided in its recognition of vowel quality by a feeling of absolute pitch, the vowels would be recognized from the presence of partials of slightly different pitch—the ear locating, as it were, the distance of the fixed pitch by the loudness of the reinforced harmonic.

In ordinary speech the voice is rarely on a level, but is constantly gliding upwards or downwards. When a vowel is spoken, the pitch of the voice is constantly changing. The reinforced partials must also change in pitch, swelling and dying away in intensity, as they approach or recede from the proper pitches of the mouth cavities. Thus, in the rapid succession of reinforced partial tones, accompanying an inflection of the voice, a point of maximum resonance should be perceived having the absolute pitch characteristic of the vowel uttered.[1]

Treating vowels as we find them, as *genera* of sounds, instead of individuals, the most plausible theory seems to be what we may term "the harmonic fixed pitch theory of vowel sounds," according to which a vowel is a musical compound, of partial tones, whose frequencies are multiples of the fundamental of the voice; the predominant partials being always those that are nearest in pitch to the resonance cavities formed in the mouth by the position of the vocal organs assumed during the utterance of the vowel.

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[1] It is well known that the duration of a vowel is an element in determining its quality. It is extremely difficult to detect the quality of short vowels, and they are often spoken of as "obscure."

THE LOGOGRAPHIC VALUE OF CONSONANT SOUNDS IN RELATION TO THEIR TRANSMISSION BY TELEPHONE.

BY CLARENCE J. BLAKE, M.D.,

BOSTON.

THE following paper is based in part upon experiments made in the winter of 1874–'75, on the graphic illustration of sound waves by means of the human membrana tympani,[1] and in part upon experiments made in the winter of 1877–'78, to determine the character and relative extent of the excursions of the disks of the transmitting and receiving Bell telephones, the capacity of the telephones in question for the transmission of high musical tones, and the relative transmission by telephone of consonant sounds.

The latter experiment was suggested by the observation previously made in testing some of the earlier forms of the Bell telephone, and found to pertain, though in a lesser degree, to the forms at present in general use, that certain consonant sounds were less distinguishable through the receiving telephone than others, and that these with certain exceptions later mentioned, were precisely the consonant sounds most readily distinguishable when transmitted through the air.

The present observations, therefore, are to be taken as referring only to magneto-electric telephones; that is, to telephones in which an undulatory current is induced in the coil and upon the line wire by the vibrations of a metallic disk or armature in front of a permanent magnet, and furthermore, to telephones, in using which for vocal transmission, more or less varying pneumatic pressure is brought to bear upon the outer surface of the disk of the transmitting telephone, especially in consequence of the necessity of speaking directly into the mouth-piece of the telephone.

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[1] Trans. Boston Soc. Med. Sciences, Dec., 1874.

In ordinary speech there is, with the utterance of each consonant sound, a more or less forcible expulsion of air from the mouth and nose, the force used in the production of each consonant sound varying not only in degree, but in the manner of the distribution of the force; and, since a certain definite position of the articulating apparatus is required to produce each consonant sound, it would be expected that the distribution of pneumatic pressure would be more or less constant for each consonant sounded independently. When several consonants are sounded in rapid succession, as in a spoken word, there is, as was first shown by Mr. Barlow, a modification of the degree of pneumatic pressure and its distribution, distinctive of the individual consonant, the general characteristics of the consonant sounds in this respect, however, remaining distinguishable.

For determining the pneumatic force equivalent of the consonant sounds, various instruments may be employed; the degree of the pneumatic pressure may be measured by means of a manometer fitted to a mouth-piece, including the mouth or mouth and nose, and by means of a "sound-mill" similar to that employed by Dvorák and Mayer in experiments on acoustic repulsion;[1] both the degree and the distribution of the pressure may be observed, and also recorded by means of the logograph first devised by Mr. Barlow,[2] or by means of the membrana tympani logograph[3] with which the tracings illustrating this paper were made.

In obtaining logograms, as well as in obtaining phonautograms, it is exceedingly important that the recording plate should move at a uniform and definitely determinable rate of speed; and this having been provided for in the apparatus employed for using the human membrana tympani as a phonautograph and logograph, it was found that, at a medium rate of the speed employed for the production of one or the other class of tracing, a combined curve could be obtained, representing, in the production of a consonant sound, not only the curve corresponding to the excursion of the membrane under the pneumatic pressure, but also the excursions of the membrane in response to the accompanying vowel sound.[1] (Figs. 3, 4, 5, 6.) Similar phonauto-logographic curves have since been made by Mr. Barlow.[2]

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[1] Amer. Jour. Science and Arts, XVI., July, 1878.

[2] Trans. Royal Soc., April 16, 1874.

[3] A New Use of the Membrana Tympani. C. J. Blake, Trans. Mass. Med. Soc., June, 1875.

The bearing which these combined excursions of the membrane have upon the telephonic transmission of consonant sounds is readily seen from the following considerations:

1. The metallic disk of the telephone responds to the impulse of the voice in the same manner as does the membrane of the logograph, though in a lesser degree.

2. For the return half of each whole vibration it is dependent upon its own elasticity.

3. When in place in the telephone the attractive force of the magnet serves to diminish the return half of the vibration of the disk, this diminution of vibration increasing as the disk is more nearly approximated to the magnet; the damping effect of the magnetic attraction upon the vibration of the disk being expressed as inversely proportional to the square of the distance between the pole of the magnet and the disk.

4. The pneumatic pressure accompanying the production of consonant sounds when spoken directly into the mouth-piece of the telephone, by forcing the disk nearer the magnet, increases the damping effect of the latter upon the vibrations of the disk, and this damping effect is then in proportion to what may be called the logographic value of the consonant sound.

Those consonant sounds, therefore, which require the greatest force for their expression, by pressing and maintaining the disk of the telephone nearer the magnet during the vibration of the disk in response to the accompanying vowel sound, proportionately diminish the excursion of the disk in vibration; and when consonants are sounded in connection with vowels, as in a spoken word, the consonant sounds having the greatest logographic value are most readily confounded with each other and most obscure the accompanying vowel sound.

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[1] **Sound and the Telephone. C. J. Blake. London, May, 1878. Br. Soc. Tel. Eng.**

[2] **Logographe. Barlow: Jour. de Physique. Paris, April, 1879.**

It has been determined by experiment that the consonant sounds of the English language possessing the highest logographic value, T, P, B, and D, for instance are those most readily mistaken one for the other in telephonic transmission, either when sounded independently or in relation to each other, as in a spoken word. In the same series of experiments it was also found that B was frequently confounded with M, and D with N, a circumstance in part explainable by the fact that in using either the box or hand telephone, the mouth only of the speaker is included in the mouth-piece. The position of the articulating apparatus being nearly the same in B and M, but that in B the closure of the lips is followed by the vowel sound, with considerable expulsion of air from the mouth; while in M the vowel sound precedes the closure of the lips and the expulsion of air is principally through the nose. In M and N, therefore, but slight pneumatic pressure is brought to bear upon the telephone disk, the principal excursion of which is that in response to the vowel sound, while in B and D the pneumatic pressure brought to bear upon the disk is so great, and the accompanying vowel sound so short as to allow the increased damping effect of the magnet to obliterate in a great degree the vibrations corresponding to the distinctive partials of the consonant sounds B and D as related to M and N respectively.

The effect of the attractive force of the magnet in diminishing the excursions of the disk of the telephone in vibration, and the effect of the consonant pressure in forcing the disk still further within this damping influence, are shown by the following measurements:

1. To the centre of a disk, ten centimetres in diameter, of a box telephone, was attached a platinum wire, making record upon a smoked glass plate, in response to the vowel sound A 448 v. s. sounded in the mouth-piece of the telephone, the magnet having been removed; measured under a microscope with micrometer eye-piece, of twenty records, the average excursion of the disk was found to be 0.2625 millimetre. The magnet being put in place, the deflection of the centre of the disk due to magnetic attraction

was found to be 0.061 millimetre, and the excursion of the disk in response to the tone previously employed was found to be only 0.190 millimetre, a difference in the length of the excursion of 0.0725 millimetre, or about 27.65 per cent.

2. To determine the excursion of the disk of the telephone under pneumatic pressure of the consonant sounds, the graphic method was first employed, but found to be inadequate on account of the slight excursion of the disk and the proportionately slight difference between the records of the different consonants ; the following experiment gave more satisfactory results. A Bell hand-telephone (resistance 75 ohms) having a ferrotype disk 6 centimetres in diameter, was connected by copper wire (resistance 0.342 ohm) with a Thompson short-coil reflecting galvanometer (resistance 0.645 ohm), and the consonants sounded separately in the mouthpiece of the telephone. To insure uniformity of production each consonant was sounded with the lungs fully inflated, and for each consonant a series of six readings of the scale was taken. The consonants having the greatest logographic value, as determined by previous tracings made with the membrana tympani logograph and compared with the tracings published by Mr. Barlow,[1] produced, as would be expected, the greatest deflection of the galvanometer, these were T, P, B, D and G. M and N produced the least deflection on account of the direction of the expulsive force principally through the naso-pharyngeal space and nose, and but slightly through the mouth upon the disk.

The accompanying plate is an endeavor to represent, by means of tracings made with the membrana tympani: 1. The excursions of the disk in response to the vowel sounds E and A (Figs. 1 and 2), these being the vowel sounds accompanying the production of B, D, and K. 2. The diminished excursion of the disk in response to the same vowel sounds in combination with consonants, that is, under the influence of the pneumatic pressure accompanying the production of the consonant sounds B, D, and K (Figs. 3, 4, and 5). Fig. 6 is a record of the consonant K, exhibiting for purpose of comparison tracings made—1. The recording plate moving at a rate of five millimetres in the second, showing the distribution of pressure, consonant curve. 2. The recording plate moving at a rate of five centimetres in the second, showing the combined consonant and vowel curves.

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[1] Popular Science Review, July, 1874.

A comparison of the vowel curves of Figs. 3, 4, 5, and 6, with the corresponding curves in Figs. 1, and 2, suggests the effect which the pneumatic pressure alone would have in diminishing the excursion of the telephone disk in vibration, without reference to the still further diminution consequent upon the damping effect of the magnet.

PHLEBITIS OF THE VENÆ EMISSARIÆ MASTOIDEÆ.

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Of the emissary veins which, passing through the skull, connect the venous circulation within the cranium with the venous circulation of the external tissues, eight are known to exist. The most important of these are the emissaria mastoidea, emissaria condyloidea, emissaria parietales, and the emissaria occipitales, and by far the largest and most important of all are the emissaria mastoidea, which emerge from the skull just behind the mastoid processes, and furnish a direct venous connection of considerable size between the lateral sinuses within the skull and the occipital veins of the surface. Of the other emissaries, the emissarium condyloideum passes through the condyloid canal and connects the plexus vertebralis cervicalis with the lower end of the lateral sinus; the emissarium parietale, through the foramen parietale, connecting the veins of the scalp with the superior sagittal sinus; the emissarium occipitale, through a fine opening in the occipital protuberance, connecting the occipital veins with the sinus near the torcular Herophili. While most of these emissaries are small, and somewhat variable both in size and position, those of the mastoid are large and very constant.

In the three following cases, the only ones which I have ever met with, we had, in my opinion, to deal with a phlebitis of these emissaria mastoidea, in all probability due to an extension of inflammation from the lateral sinuses with which, as has been said, they are in direct connection. In all of the cases the prominent and characteristic symptom was the peculiar induration of the tissues of the neck, such as characterizes a cellulitis dependent upon phlebitis, and one of the best examples of which is seen in phlegmasia alba dolens.

The close relation of the lateral sinuses with the mastoid cells is well known; they are separated from the cells merely by the thin, inner, osseous wall of the cells, which is perforated usually by very numerous foramina filled with connective tissue, and possibly, in some cases, by minute blood-vessels. That these sinuses become involved in inflammation, which extends from the mastoid cells and tympanum, has been proven frequently by dissection, and phlebitis and thrombosis of the lateral sinuses have been found not only with extensive caries of the mastoid, but also with simple inflammation of the lining of the cells, the extension of the inflammation being traced, in these latter cases, to the connective tissue filling the minute foramina.

CASE I.—T. M., clerk, aged twenty-two years, was first seen in the out-patient department of the City Hospital on May 27, 1870. He was then suffering from a purulent inflammation of the right tympanum of some weeks' duration; the membrana tympani showed a small perforation, the mastoid cells were inflamed, and a small mastoid abscess had ruptured externally of its own accord a few days before. No caries could be discovered with the probe.

After receiving advice, he was ordered to report again in two days, but was not seen again till June 22d, when he returned and said that he had been confined to the house for four weeks with severe pain in the head and right ear. He was very much emaciated, and complained of continuous, very severe pain in the right ear and over the right side of the head. The discharge from the meatus continued profuse; the membrana tympani was in the same condition as when first seen, and air could be easily forced through the perforation by Valsalva's inflation. The rupture of the mastoid abscess had healed, and at its site was a red, fluctuating and painful swelling of the size of a hen's egg. He was immediately taken into the hospital, and, under ether, the late Dr. Thaxter made an incision, two inches long, into the abscess and through the periosteum, evacuating a quantity of laudable pus; the bone was not softened or carious. From this time I saw him occasionally with Dr. Thaxter. Frequent douchings of the meatus with warm water and poultices to the wound were ordered.

June 23d.—The pain in the ear and head was very much less. Pulse 76; appetite fair.

June 27th.—The discharge from the meatus was very much diminished. There was, however, increased pain and tenderness over the mastoid, and a slight, hard induration of the tissues downward and backward from the seat of incision. The wound was healing.

July 1st.—The induration from the mastoid had extended down the neck and towards the spinal column; it was hard, without redness, and on palpation clearly defined edges could be felt. The general condition was, however, good; the pulse was normal, the appetite better, and the wound was healing well.

July 6th.—The induration involved nearly the whole of the right side of the neck, from the spinal column to the sterno-mastoid muscle. He also now complained of periodical pain and tenderness over the occipital protuberance, the pain coming on about six o'clock P.M., and continuing for some hours, and then ceasing entirely. Pulse was 94. Quinine, in two grain doses, was ordered every two hours through the afternoon.

July 8th.—There was less pain and tenderness over the occiput. The induration of the neck had extended beyond the median line behind towards the other side; it was red and sensitive, but without fluctuation. There was some œdema of the eyelids, but the sight was unaffected. Pulse 84; urine normal; appetite and strength good, the latter much better than on entrance.

July 14th.—The anterior portion of the induration of the neck had now become a painful, fluctuating swelling, which produced difficulty in swallowing. The pain in the occiput still continued. Pulse 100. Under ether the fluctuating swelling was incised, by Dr. Thaxter, below the mastoid, and a small amount of pus evacuated; another incision was made over the mastoid, and a seton passed through the two openings. Pus was found to have burrowed quite extensively in the tissues of the neck. The operation relieved the pain in the neck entirely; the occipital pain continued, and required sulphate of morphia, gr. $\frac{1}{8}$, subcutaneously. The pulse varied from 84 to 94, and the general condition became rather worse, till

July 29th.—The pain in the occiput became very much less; he was able to sleep without opiates, and could walk about the ward. The induration of the neck continued; the wounds had ceased to suppurate freely, and the seton was removed; the œdema of the eyelids had disappeared.

August 2d.—The occipital pain again returned.

August 6th.—The pain was referred to the whole head. The condition of the ear itself had improved; the discharge was slight; the mastoid had healed without any caries being discovered, and there was no pain in the ear.

August 14th.—The pain in the head required morphine, gr. $\frac{1}{8}$, and atropine, gr. $\frac{1}{60}$, subcutaneously. He began to complain of a very tender spot over the occipital protuberance, and vomited after each meal.

August 23d.—Morphine, gr. $\frac{3}{8}$, was now required to relieve the pain. Over the occipital protuberance a small tumor, of the size of a pea, had formed; was incised, and a minute quantity of pus evacuated.

August 27th.—The pain in the head and the vomiting continued. Pulse 80.

September 4th.—The pain in the head had become intense. At two o'clock P.M. he was found in a semi-comatose condition, with sluggish and contracted pupils; pulse 80, and respiration 10. This was followed by frequent vomiting and profound coma, and in the evening general tonic convulsions set in, lasting some ten minutes, and in these he died. No autopsy could be obtained.

CASE II.—Lizzie H., aged seventeen, a domestic, entered the Massachusetts General Hospital March 12, 1875. Five weeks before, after exposure to cold, there was pain in the left ear, followed by discharge for some days. Since then there has been gradually increasing pain, tenderness and induration in the mastoid region and neck on the left side, but no pain or discharge in the ear.

March 16th.—I saw her in consultation with Dr. R. M. Hodges. She was about the ward, and the general condition was good. Examination of the left ear showed the membrana tympani very much sunken, nearly resting upon the promontory, and perhaps a little thickened; it was entirely free from redness and swelling. The hearing for the watch was $\frac{5}{72}$. Externally was a hard induration, beginning over the mastoid, and extending down the neck for some three inches and backward nearly to the median line; it was without redness or œdema, but was quite sensitive on pressure. Poultices, opiates p. r. n.

March 21st.—The pain in the induration has been increasing in severity, otherwise no change. Under ether Dr. Hodges incised the periosteum of the mastoid; no pus was found. The mastoid cells were then opened by a trephine; the bone was perfectly healthy, and the mucous lining of the cells was entirely free from swelling, redness, or secretion.

March 26th.—There is much less pain since the operation and the induration over the mastoid has diminished; that of the neck remains the same.

March 29th.—There is severe pain along the anterior border of the sterno-mastoid muscle, with marked œdema and great tenderness on pressure at this point; also decided erysipelas of left side of face. Quiniæ sulphas, gr. ij. t. d.

March 31st.—The erysipelas is better. General condition worse; appetite failing; pulse 98, temperature 100.

April 2d.—Neck still very painful and tender. The erysipelatous blush has disappeared. The back of the neck, just below the margin of the hair, is extremely sensitive to the touch. Now keeps in bed, having previously preferred to be about.

April 3d.—Some two inches back of the mastoid there is distinct fluctuation, and, under ether, Dr. Hodges incised the tissues and evacuated a large amount of pus, which had burrowed quite deeply in the neck; an artery of considerable size was cut and required ligation.

April 4th.—Complains of dyspnœa and weakness; pulse 118, temperature 99. Stimulants.

April 5th.—Much dyspnœa last evening, which was relieved by morphiæ sulphas, gr. $\frac{1}{8}$, subcutaneously. This morning unconscious; breathing better; pupils not contracted; pulse 120, and very weak. Two purpuric spots, one over right eye and the other on the right forehead. The right auricle is quite purple. During the day the pulse became weaker, the right auricle became still darker in color, and at eleven P.M. she died, without new symptoms. Autopsy could not be obtained.

CASE III.—Esther D., aged twenty-one, strong and healthy, had had a continuous otorrhœa on the right side since early childhood, till within a year, when she says there has only been occasional slight discharge, but no pain; the ear was somewhat deaf.

About one week before I saw her she took a severe cold, and complained of pain in the right ear and on left side of head; with this there was some dulness at the base of one lung. The constitutional symptoms were slight, the dulness of the lung cleared up, leaving only a slight bronchitis; the pain in the ear and head were never very severe. There was no discharge from the ear externally, and she seemed to be going on well till February 18th, when she complained of severe pain behind the right mastoid, which was soon followed by a hard induration of the tissues below the seat of pain; at the same time there was a decided rise in the pulse, with hot skin.

The next day, February 19, 1879, I saw her in consultation with Dr. J. G. Blake. There was more marked constitutional disturbance than on the previous day, and there had been very slight delirium. The chief complaint was of the pain at the seat of induration. The pulse was 120, skin hot. Examination of the ear, the patient being able to sit up in a chair, showed the meatus filled with a thin, muco-purulent discharge; the drum-membrane and ossicles were gone, and the tympanic mucous membrane was somewhat thickened, swollen, and inflamed. Over the mastoid was no tenderness, even on deep pressure, and the tissues there were free from œdema or redness. Below and behind the mastoid was a hard induration of the tissues, extending down the neck for some two inches in length and the same in breadth, with irregular, sharply-defined edges. The whole induration was very sensitive, but most so at the point close to the base of the skull. There was no redness of the skin, no distention of the veins, and no tenderness along the jugular vein. Examination of the lungs showed only slight bronchitis; the heart sounds were normal. She was ordered nourishment, chiefly milk, quinine, an opiate at night, and six leeches over the induration.

February 20th.—I saw her again with Dr. Blake; there was more decided delirium, a pulse of 132 and weaker, and a temperature of 104.1°. The induration of neck was more extended, and there was some swelling above the normal plane of the tissues; the skin was slightly red; no fluctuation. Two well-marked purpuric spots, one inch by one-half an inch, had appeared on the left side, one just below the jaw and one over the clavicle; no others were found on the back or on one leg, the only parts examined. No *tache cérébrale*.

From this time she gradually became unconscious, and without any new symptoms died within twelve hours. No autopsy.

All three of these cases, it will be noticed, had two characteristics in common, the induration of the neck, and, finally, fatal symptoms. The induration in all was peculiar and readily distinguishable from any of the more common forms of inflammation in that region, such as mastoid abscess, inflamed glands or furuncle. The tissues, without being swollen above the normal plane, were at first extremely hard, feeling like a board; the edges of the induration were felt distinctly; the color of the skin was normal. As the disease progressed the tendency was for the induration to extend toward the posterior aspect of the neck and the occiput rather than toward the face. In two of the cases during the later stages of the disease suppuration occurred in parts of the indurated tissue, and on incision the tissues were found to be infiltrated with pus. In two of the cases purpuric spots appeared on the face and upper part of the chest during the last twenty-four hours of life.

In only one of the cases was the induration seen early enough to make out the exact spot from which it started; in the third case it was certain that it began directly behind the mastoid, just at the base of the skull, and from here was steadily extending downward and backward till the time of the patient's death.

All three cases were either immediately preceded or else accompanied by a purulent inflammation of the tympanum of the affected side; in the first case the tympanic inflammation was acute and followed by inflammation of the mastoid cells and external suppurative periostitis; in the second case there had been purulent tympanic inflammation a short time before without, so far as could be determined from the history, any extension to the mastoid cells, certainly without any external periostitis; in the third case there was chronic purulent inflammation of the tympanum of many years' standing, but no external periostitis or symptoms referable to the mastoid, although, from the long continuance of the tympanic disease, it was probable that there was also more or less inflammation of a chronic character in the mastoid cells.

In all of the cases when first seen the symptoms pointed only to the local trouble in the ear and neck; in the first case, to be sure, there was great pain in both ear and head, but not more than is common with a large mastoid abscess, such as existed when this patient returned to the hospital, and both these pains were relieved by the evacuation of the mastoid abscess; in the other two cases the symptoms were merely local pain in the induration of the neck or in the ear. In none of the three did the pulse, temperature, or appetite show any marked disturbance of the general system, nor was there, at first, any reason to anticipate, from the appearance of the patients, a fatal termination to the disease.

The succession of the symptoms in the several cases was as follows: in the first, acute inflammation of the tympanum and mastoid with external mastoid abscess, induration of the neck below and behind the mastoid, periodical pain in the occipital region, œdema of the eyelids, suppuration of the induration, general pain in the head, suppuration over the occiput, vomiting, coma, convulsions, and death seventy days after the appearance of the induration; in the second case there was acute suppuration of the tympanum which had healed, induration of the neck, pain, tenderness and œdema along the course of the jugular vein, facial erysipelas of the affected side only, suppuration in the indurated tissues which were incised, dyspnœa, coma, purpura, and death thirty-six days after the appearance of the induration; in the third case there was chronic suppuration of the tympanum, slight pneumonia, induration of the neck, with delirium, fever, purpura, and death two days after the appearance of the induration.

The treatment adopted in these cases, although it had no influence on the course of the disease, is of interest in assisting us to arrive at the origin of the trouble. In the first, although a large mastoid abscess had formed externally and had existed for some weeks, the operation showed that the external wall of the mastoid cells was not carious or softened, and the subsequent suppuration which occurred below and behind the mastoid was a suppuration in the indurated tissue of the neck, the mastoid abscess having in the meantime healed; in this patient the pain was referred chiefly to the occipital region, and was of the very intense character only seen with disease of the brain; after it had continued for some time a small spot of suppuration occurred beneath the periosteum over the occipital protuberance, just at the spot where the occipital emissary vein emerges from the skull. In the second case, although the symptoms of mastoid inflammation were wanting, it was thought best to trephine the mastoid cells to avoid the possibility of any retention of the products of inflammation there; the operation showed that the external wall was perfectly normal, and no inflammation existed within the cells; the induration of the neck had existed for two or three weeks before the operation, and was in no way influenced by it, except that the pain, previously referred to the neck, seemed to be somewhat relieved for a time, either due to the revulsive action of the operation or to the free bleeding. In the third case free leeching only was resorted to, but without influence on the disease; remembering the two previous cases, and that the result of the operations in both of those showed that the disease was independent of any condition which could be relieved by surgical procedure, I was unwilling to advise any operation.

In regard to the final fatal symptoms: in the first case there can be no doubt that death was due to disease of the brain, coma setting in and being followed by convulsions of considerable duration, during which death occurred; in the second case, the first alarming symptom was violent dyspnœa followed by unconsciousness, purpuric spots on the face, and death, very probably caused by septicæmia or emboli, or both; in the third case delirium and fever were rapidly followed by purpura and death, the symptoms, so far as they were developed, pointing to the brain.

The symptoms of thrombosis and phlebitis of the brain sinuses are by no means clearly defined, or rather they are so multiform and so often complicated with other diseases that the diagnosis is by no means simple. Wreden, from an analysis of one hundred and fifty-one cases,[1] has called attention to the anatomical relations of the circulation of the external skin which is connected with the sinuses as a great aid to the diagnosis. When the cavernous sinus is obstructed, passive congestive œdema occurs in the parts drained by the ophthalmic vein; this congestion showing itself by œdematous swelling of the nostril, forehead, and eyelid, by hyperæmia of the retina and swelling of the nasal mucous membrane, with bloody discharge. Thrombosis of the superior longitudinal sinus is characterized by repeated violent hemorrhages from the nose, and by epileptiform convulsions, which Wreden refers to capillary hemorrhages in the cortical substance of the posterior cerebral lobes, produced by obstruction to the venous circulation of the surface of the brain. Thrombosis and phlebitis of the lateral sinus is shown by œdematous swelling of the soft parts in and about the external ear which has, he says, exactly the character of phlegmasia alba dolens; there is frequently also constant dizziness and a staggering gait. As the disease progresses, the obstruction extends down the internal jugular vein, and the phlegmonous inflammation extends downward along the course of that vein toward the clavicle, the greatest swelling and tenderness being along the vein. Congestion of the facial vein and œdema of the face follow from the obstruction in the jugular vein, but a collateral circulation is soon established through the branches to the external jugular, and this œdema is soon relieved unless the facial vein itself becomes closed, when there will be very great and continuous œdema of the face, and if the phlebitis extends to the smaller veins there will be a distinct erysipelas of the cheek and forehead. These symptoms of disease of the sinuses have now been confirmed by a very considerable number of cases by other authors, recently by Rammel,[1] Kolb,[2] Taylor,[3] although they are by no means invariably present, or they may be so masked or transitory as to escape observation.[4]

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[1] St. Petersburger Medizinische Zeitschrift, Vol. XVII., and Boston Med. and Surg. Journal, May 18, 1876. Report on Otology.

These characteristics of thrombosis of the lateral sinuses as given by Wreden, although not present in the very marked degree that they have attained in many cases, were not altogether absent in the three cases here reported. In the first case there was, for some days, decided œdema of the eyelids, but the whole history shows that the disease tended to extend backward rather than forward, as shown by the pain in the occiput, and suppuration over the occipital protuberance; this severe pain in the occiput was a prominent symptom in the third of Moos' cases where the autopsy proved the death to be due to meningitis from thrombosis and phlebitis of the lateral sinus, caused by chronic inflammation of the mastoid cells without caries. In the second of my cases there was pain, œdema, and tenderness along the course of the jugular vein, followed by transitory erysipelas of the face, as described by Wreden. In the third case, the patient evidently succumbed to the intensity of the disease before there was time for any of the symptoms to become pronounced. The absence of marked symptoms in the general system does not at all militate against the existence of thrombosis of the sinuses, for the same thing is found in many of the cases supported by autopsy; in two of my cases the strength and appetite were unimpaired, and the pulse and temperature normal for a considerable time after the onset of the disease. In fact, in the cases of established thrombosis, such is the rule, until the clot has extended to other veins, or emboli enter the general circulation, or phlebitis sets in.

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[1] Der Feldartz, No. 25, 1876.

[2] Berliner klinische Wochenschrift, No. 46, 1876.

[3] Med. Times and Gazette, Apr. 28, 1877.

[4] Moos: Archives of Ophthalmology and Otology.

The œdema around the ear spoken of by Wreden with disease of the lateral sinuses, and described by Moos, in the fourth one of his cases, as extending from the temple to the tragus, must be referred to obstruction of the posterior facial vein, which joins the common facial near the angle of the jaw. Obstruction and inflammation of the mastoid emissary veins is mentioned incidentally in some of the cases which have been reported, but I am not aware of any in which the induration and inflammation of the posterior aspect of the neck was the early and prominent symptom as in the three cases here recorded.

It might be a question in these cases whether the disease began external to or within the skull; in the first, where there was a large external mastoid abscess, the external origin is certainly possible from the vein becoming involved in the previous inflammation. In the second case, there was, however, no preceding external inflammation, and the induration of the neck was soon followed by pain and tenderness along the jugular vein, and by facial erysipelas, symptoms which could only be referred to inflammation of vessels directly connected with the sinuses, and not connected with the parts involved in the induration. In the third case, there was no previous external inflammation, and induration began exactly at the spot where the emissary vein emerges.

A most striking fact is noticed in examining the reported cases of thrombosis and phlebitis of the lateral sinuses. In many cases the disease is excited by simple, uncomplicated inflammation of the mastoid cells, which extends, by continuity, along the connective tissue filling the minute foramina of the inner osseous wall of the cells; in others the whole mastoid is in a state of caries or necrosis, and the sinus embedded in suppurating granulation-tissue, and yet neither thrombosis nor phlebitis exists.

A short analysis of the symptoms in several cases of thrombosis of the lateral sinus, which have been recently reported, may be of interest in this connection.

Rammel [1] reports briefly one of chronic tympanic inflammation on the right, where the patient entered the hospital on October 21st, with typhoidal symptoms, a temperature of 101.3°, and a pulse of 120. On October 23d there was pain in the head and nape of the neck, œdema and tenderness over the mastoid, and lobular pneumonia; then followed right facial paralysis, œdema of right upper eyelid, chemosis, exophthalmos, dilated pupils, somnolence, swollen spleen, œdema of the left lid and right temple. The pulse was then about 60. November 3d, there was chemosis of both lids, mild delirium, anæsthesia of the right half of the face, swollen liver and spleen, diarrhœa and pneumonic infiltration of the right lung. November 6th, the œdema of the lids and mastoid, the facial paralysis and anæsthesia had disappeared. November 8th, there was pneumonia of the left lung, and gradual symptoms of gangrene of the lungs with death.

During the disease, the stiffness and pain at the back of the neck, the otorrhœa, deafness, and exophthalmos remained constant; the facial paralysis, œdema of mastoid and lids, difference in the pupils, the swelling of the liver and spleen, and the pneumonia varied several times. The autopsy showed caries of the tympanum, thrombosis of the right lateral sinus, phlebitis of the jugular vein, and metastasis to the lungs. The thrombus extended from the right lateral sinus through the inferior petrosal to the cavernous sinus, thence through the circular to the left cavernous sinus, which was filled with disorganized clots and with pus.

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[1] **Feldarzt, No. 25, 1876.**

A case reported by Kolb[1] is of great interest from the multiplicity and undoubted character of the symptoms, and especially from the fact that the patient recovered, at least for the time, and was discharged from the hospital. A girl, aged seventeen, had had occasional otorrhœa for several years, but the exact condition of the ear seems never to have been determined. On October 23, 1875, there began a bloody discharge from the right ear, which ceased after eight days; at the same time there was headache on the right side, sleeplessness, daily chills, œdematous inflammatory swelling of the skin over the right mastoid, with swelling of a vein at that spot; a similar swelling of the eyebrows and of both eyelids, exophthalmos of the right eye, photophobia, vomiting, delirium, constipation, general convulsions, hyperæsthesia, clonic spasms of the right arm and right leg, mistiness of vision, small hemorrhages in the skin of the rump, pain in the chest, dry cough, and hemorrhages from the right nostril. The pulse varied between 62 and 90; the temperature was normal throughout; all the symptoms disappeared between November 19th and 23d, but many of them returned, together with the coughing of blood, and again disappeared to return for the third time; by the 6th of January they had again disappeared, and there had been no recurrence one month later, when the patient left the hospital apparently well. Kolb calls special attention to the repeated improvement and relapse in this case.

A case reported by Taylor[2] is unusual, in that the final symptoms were decidedly those of meningitis, which the autopsy showed did not exist. There was chronic otorrhœa, followed by delirium, strabismus, diplopia, eye-disks blurred and redder than usual, with the retinal veins full and tortuous, sudden rise and fall in the temperature, some enlargement of the superficial veins of the face and chest, but no œdema anywhere. The autopsy showed thrombosis of the lateral sinus, thrombosis and phlebitis of the jugular vein, and metastatic abscesses in the lungs. The brain was normal. The cerebral symptoms in this case are referred by Taylor to disturbances in the cerebral circulation different in kind but like in effect to that which occurs in meningitis.

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[1] Berliner klinische Wochenschrift, No. 46, 1876.

[2] Medical Times and Gazette, April 28, 1877.

Moos[1] reports four cases: in the first there was acute inflammation of the right ear, pain in the right forehead and temple, slight chills, constipation, debility, somnolence, photophobia, and impaired vision, delirium, repeated severe chills, sudden rise and fall of temperature, consolidation of the lungs, stupor and death. No œdema anywhere. The autopsy showed thrombosis of the right lateral sinus and internal jugular vein; slight phlebitis of the emissary mastoid vein; metastatic deposits in the lungs. In the second case there was chronic otorrhœa on the right, of one year's duration; intense pain on the right side of the head, and death. The autopsy showed thrombosis of the sigmoid flexure of the right lateral sinus and lepto-meningitis. In both of these cases the extension of the inflammation from the ear to the sinus was traced to the connective tissue filling the foramina. In the third case there was chronic inflammation of the right tympanum, chills, pain in the occiput, vomiting, dyspnœa, opisthotonos and death. At the autopsy there was found to be phlebitis and thrombosis of the lateral sinus, and meningitis cerebralis. The mastoid cells were filled with a cholesteatomatous mass, and the inflammation had extended to the sinus along the connective tissue as in the previous cases. In the fourth case there was old caries of the petrous bone, pain in the ear, forehead, and occiput, fever, œdematous swelling extending from the temple to the tragus, diffuse headache, stupor, spasms of the upper extremities, and death. The autopsy showed phlebitis and thrombosis of the lateral and superior petrosal sinuses, with circumscribed basilar meningitis.

Burckhardt-Merian[2] reports one case in a child two years old, with extensive caries of the left petrous bone and external openings over the mastoid; there was vomiting, delirium, bloody discharge from the nostrils, spasms of the extremities, purulent inflammation of the nasal mucous membrane, sluggish pupils, a temperature of 102.2° and pulse from 132 to 144. These symptoms were followed by convulsions, sharp cries, violent tossing of the head, and death. The autopsy showed tubercular meningitis, caseous pneumonia, and pyo-pneumothorax; there was also thrombosis of the left lateral sinus, but the connection of this with the fatal diseases was not evident.

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[1] Archives of Ophthalmology and Otology, vol. vii., No. 4.

[2] Archiv für Ohrenheilkunde, vol. xiv., p. 178.

THE VALUE OF ATROPIA IN THE TREATMENT OF ACUTE INFLAMMATION OF THE MIDDLE EAR.

By SAMUEL THEOBALD, M.D.,

BALTIMORE, MD.

Although the marvellous efficacy of atropia, as a remedy in the treatment of diseases of the eye, is universally acknowledged, its value, as an agent in aural therapeutics, does not appear to have received the recognition which it deserves.

Several years since my attention was directed to the use of atropia in inflammatory affections of the ear, by a brief abstract of an article upon this subject from one of the foreign journals, which, if I mistake not, appeared in the *American Journal of the Medical Sciences.* Familiar with the action of this remedy in diseases of the eye, I was disposed to regard with favor the suggestions here put forth as to its usefulness in affections of the ear as well; and I began at once to test their practical value. The result of my experience since then has been to convince me that atropia, though for obvious reasons not entitled to hold the same position in aural practice that it does in ophthalmic practice, is, nevertheless, an agent of much value to the aural surgeon. Although I have sometimes found it very useful in allaying the pain dependent upon furuncular and diffuse inflammation of the external auditory canal, and possibly in favorably influencing the inflammation itself, it is in the treatment of acute otitis media—that form of inflammation of the middle ear which is accompanied by severe pain, and commonly tends to the formation of pus—that it has proved most efficacious. Especially in the acute inflammation of the middle ear resulting from colds, to which young children are peculiarly subject, and which is the usual cause of the familiar earache of childhood, is it useful, as well as in the more severe forms of otitis media which follow the exanthematous fevers.

My usual method of employing atropia has been to instil a few drops (eight or ten) of a solution of the sulphate in distilled water, into the ear, the patient being directed to keep the head in such a position that the drops shall remain in the meatus, in contact with the drum-head, for ten or fifteen minutes. The instillations may be repeated according to the severity of the symptoms, every three or four hours in very acute cases. A solution containing four grains to an ounce is the one I have generally made use of, although I think one of twice this strength might be employed with advantage where the pain is very severe and the tympanal membrane is intact.

In regard to the safety of using in this way so powerful a remedy, I may say that, where the membrana tympani was imperforate, I have never seen any constitutional effect produced by the repeated instillation of a four-grain solution, the absorption being, as might be expected, very slight. In one instance, where there existed a perforation in each drum, with slight otorrhœa, I have known dilatation of the pupils to follow the application, two or three times a day, of a solution of this strength to both ears. The patient was a little girl three or four years of age, and it seemed more than probable that the mydriasis was due to the direct application of the atropia to the eyes, as she generally indulged in a cry when her ears were attended to, and was very apt to transfer her hands back and forth between her ears and eyes. Nevertheless, I would not advise the incautious use of atropia where there existed a perforation of the drum, as in exceptional cases a sufficient quantity of the solution, by finding its way into, and possibly through the Eustachian tube, might be absorbed, to produce serious consequences. It is true that in the cases in which the use of atropia is indicated this accident is but little likely to occur, because of the swollen condition of the mucous membrane lining the tympanal cavity.

One inconvenience to which the application of atropine solutions to the ear is liable should be mentioned. When the instillations are continued for several days, a papular eruption, troublesome, because of the itching to which it gives rise, very often makes its appearance upon the auricle, and less frequently extends to the outer portion of the auditory canal. The retention of the solution in the meatus by stopping the ear with a bit of cotton, which I have sometimes practised, has, I think, conduced to this result. It would seem better, therefore, to permit the drops to run out of the ear after they have have been retained for ten or fifteen minutes, and as a further precaution the orifice of the meatus and the portions of the auricle exposed to the irritating action of the atropia might be anointed with cold cream or some other simple ointment. Where a perforation of the drum has occurred, especially if there be a copious discharge from the ear, sulphate of zinc, in the proportion of one to three grains to the ounce, may often be added to the atropia solution with advantage. It will be safest to begin with the smallest proportion named, as in acute otorrhœa astringents should be used with much caution.

As illustrating the good effects of atropia in acute inflammation of the middle ear, the following case may be mentioned: One of my own children, a little boy six years of age, convalescent from a recent attack of scarlet-fever, was taken in the middle of the night with a severe pain in the left ear. Upon examination the upper and anterior portion of the tympanal membrane was found to be deeply congested and the whole membrane dull and lustreless. Having made him use a gargle containing tincture of iodine and iodide of potassium, I warmed and dropped into the ear about ten drops of a four-grain solution of atropia. About one hour after this, as he was still awake, and the pain had not entirely disappeared, twenty-five drops of paregoric were administered. The atropia was still in the meatus, as he had not turned over since its application. Soon after this he fell asleep, and awaked in the morning free from pain. The redness of the drum-head had increased, however, and by 2 P.M. the whole membrane was intensely congested. The atropia instillation was repeated three times during the day, and the gargle used as often. There was no return of pain, and upon the day following, the congestion of the membrane was appreciably less, the treatment being the same. The next day the congestion had nearly disappeared, the bright spot began to return, and the hearing improved considerably, so that he could understand conversation in a whisper, the right ear being closed.

The atropia was applied in the morning and at night only. Two days after this, the membrane having regained its normal appearance, further treatment was discontinued. But for the atropia, a perforation of the drum with otorrhœa would in all probability have been the ultimate result. In how many instances might not a termination equally favorable be obtained, if only the opportunity for prompt treatment were afforded?

A CASE OF ACUTE INFLAMMATION OF THE MIDDLE EAR, WITH SYMPTOMS OF MENINGITIS; PARACENTESIS OF THE MEMBRANA TYMPANI; COMPLETE RECOVERY.

REPORTED BY J. L. HICKS, M.D.,

FLUSHING, L. I.

IN the history of the following case I shall not be able to narrate the facts with that minuteness of detail which would have been possible had I kept a careful record of the progress of the disease at the time. While I regret that I did not keep such a record, my brief notes furnish a sufficiently clear account of the important features of the case to render it worthy of preservation.

On the 29th of January last I was called to see Charles B., aged sixteen years, a very tall, slender, overgrown youth, whom I found in bed with fever, sore-throat, and earache. He had, I was told, taken cold after exposure, and had experienced a chill that morning. There was a boil in the external meatus of the ear, which had broken and was discharging. I prescribed for him, and ordered the ear to be syringed with warm water; and, hearing next day that he was better, I did not see him again for a week, when he was brought into my office by his mother. He seemed then to be very ill indeed. He had apparently gotten better of his first attack and had been up and about; but on the day last mentioned he had had a chill, followed by fever, and, when brought to me, had a little cough with short breathing and pain in the right side of the chest. Examination of his lung revealed merely a slightly high-pitched tubular breathing at the base of the right lung, without moist râles of any kind, or dulness on percussion. I was convinced, however, that pneumonia was impending, and this I found clearly established at my visit on the following day. The pneumonia ran its course, and at the end of ten days the lung had pretty well cleared up.

There persisted, however, a condition of prostration and general disturbance which gave me some anxiety. The temperature again began to range high. On one or two occasions I found it as high as 104° and 105° F. in the afternoon, but it sank to normal after a full dose of quinine with digitalis. After a day or two the same high temperature would recur, to be again controlled by the same agents. He was now kept upon large daily doses of quinine with ergot, and occasionally digitalis, and bromide of potassium at night, and such other measures of medication and diet as would seem to be indicated in the typho-malarial type of fever with which we apparently had to deal. During all this time there had been more or less discharge from the ear, unaccompanied by pain or noticeable impairment of hearing, and which was supposed to depend upon granulations of the external meatus successive to the abscess which occurred at the beginning of his illness. Absorbed by the stress of his other troubles I had given no particular attention to the ear, beyond ordering it to be syringed with warm water two or three times a day according to the amount of discharge, and a few drops of a weak alum solution to be instilled afterward. The discharge was thick, odorless, and occasionally tinged with red. At the end of the third week the patient appeared very much exhausted, and certain symptoms presented themselves which begot a new anxiety. The pulse, heretofore full, gaseous, and dicrotic, began to be irregular; the pupil of the left eye was larger than that of the right, and there was ptosis of the left lid. He complained of numbness of the left leg and an inability to move it or draw it up in bed; he began to have headache, severe and persistent, with delirium when dozing, and a tendency to wander when awake; and the discharge from the ear had ceased. The ominous import of these symptoms recalled attention to the ear, and I found that he could not hear my watch when placed against the ear or against the forehead. He was now ordered iodide and bromide of potassium in full doses, blisters to the occiput, cold to the head, and leeches to the auricle, which measures were followed by some abatement of headache and improvement in other particulars. He seemed to derive great comfort from strips of flannel, wrung out of hot water and sprinkled with compound mustard liniment, and applied the whole length of the spine; in fact he would ask for them every day. On examining the ear with a speculum shortly after the commencement of the new phase of the disease, the floor of the meatus appeared red and flaky but comparatively dry, and the swelling which had at first existed had disappeared. The membrana tympani had a thickened lustreless aspect, without any trace of perforation, and there was no pain that could be referred to the ear itself; the headache before mentioned seeming to centre itself more at the occiput than anywhere else.

A notable feature of this period of the history was the sudden, irregular, and wide fluctuations of temperature which took place. The body heat would rise from a point near the normal temperature to 103° or 104° F., and on two occasions to 105° F., and would then as suddenly drop back again; the whole excursion occupying not more than three or four hours.

The events constituting the second or cerebral period of the case extended over a period of about two weeks, with occasional changes that seemed encouraging, and then a lapse—alternations, however, which on the whole did not support the idea of a favorable progress. The ear was watched with considerable anxiety, and two or three times there seemed a little improvement in the hearing,—the watch could be heard a little further off, say two or three inches; but the next day things were as bad as ever.

At the end of the fifth week, on making my visit one morning, I observed some redness and tumefaction behind the ear, over the mastoid process, and lighting up the interior of the meatus with the mirror and speculum, I found the membrana tympani reddened and bulging, and on requesting the patient to perform the Valsalvian manœuvre, I saw a tiny bubble form just below the end of the handle of the malleus. I at once made a free opening through the lower segment of the drum membrane, and a gush of blood and matter followed. Inflation by Politzer's method seemed to complete the evacuation of the tympanic cavity, and I left my patient with the hope that at least one element of his danger had for the time been disposed of. The next day the opening had not entirely healed and inflation caused a little exudation of a thin red fluid. The post-auricular swelling and redness had disappeared, and the condition of the patient was surprisingly better. The temperature was normal and had been so during the night. The headache had almost gone, and he could hear my watch at a distance of twelve inches.

The history of the case practically ends here, for from this time convalescence went on without interruption, and, although the patient was deplorably weak, his strength increased day by day, with renewal of appetite and digestive vigor.

The occurrence and sequence of symptoms following the subsidence of the pneumonia appear to me clearly to indicate cerebral irritation tending to meningitis, even if meningitis to a limited extent was not actually established. It is *not* altogether clear what relation the tympanic trouble held in the order of events, although it is not improbable that its beginning may have been coincident with the abscess of the external meatus which happened at the beginning of the illness. However that may be, there is scarcely room for doubt that the middle-ear disease, whether creeping from the throat through the Eustachian tube, or propagated from the external meatus, was the active factor in developing the cerebral symptoms with which it was associated, and I cannot but think that with a membrane so resisting, and with mastoid appearances so threatening, only the free and timely evacuation of the tympanic cavity prevented a meningitis of disastrous proportions.

BOOK NOTICES.

MOLECULAR PHYSICS AND SOUND. FREDERICK GUTHRIE, PH.D. Longmans, Green & Co., London.

THIS little work, comprising in all one hundred and fifty-six pages, of which fifty are devoted to the subject of sound, is one of the series of the London science class books edited by G. Carey Foster and Philip Magnus, now in process of publication. The works in this series are all composed with special reference to their use in school-teaching, and the volume in question has carried out the object intended in a concise and yet sufficiently elaborate manner; and while the treatment of the subject is strictly elementary, the fundamental facts are stated with sufficient fulness. The chapters on sound, four in number, treat successively of waves, governed by elasticity, notes, detection, reflexion, absorption, refraction, and dispersion of sound.

Origins of sound waves—transverse vibrations of rods, composition of vibrations, transverse waves in strings, nodes, stationary waves, vibrating strings as sources of sound, musical scale, nodes in rods, nodes and segments of vibrating plates.

The gas wave—vibrations in gases, closed and open tubes, nodes in open tubes, resonance.

Longitudinal vibrations in liquids and solids—transmission of sound, the string telephone, interference, beats, singing flames, sinuosities, effect of motion of source of sound, sympathy, approach caused by vibration, the phonograph.

These chapters, illustrated by fifty-three woodcuts, form a valuable compend of the subject treated so far as is necessary for the purpose intended, namely: assisting teachers in bringing practical work into their teaching. Among the books of this series in preparation are: The Senses and the Voice, by John G. McKendrick, M.D., F.R.S.E.; and Vibratory Motion and Sound, by J. D. Everett, D.C.L., F.R.S.E.

OPENING THE MASTOID PROCESS BY OPERATION. BY PROF. SCHWARTZE. Archiv für Ohrenheilkunde, vii.-xiv. Bd.

IN 1872 Prof. Schwartze began a series of articles on the artificial perforation of the mastoid process, which are just completed, the whole forming a continuous article of one hundred and eighty-nine pages. It is a most valuable and thoroughly scientific investigation of the entire subject. It is seldom that any operation has undergone a more searching examination, and it is doubtful if any operation was ever submitted to such a strict historian so early in its history, for although the opening of the mastoid cells by surgical procedure is by no means new, yet the earlier operations were undertaken without any definite knowledge of the pathological conditions which existed, and the real scientific history of the operation is confined to the last ten years.

Schwartze (with whom in the first number of the series Dr. Eysell is associated) begins with a review of the history of the operation, which was for a long time known as Jasser's operation, from Dr. Jasser, a Prussian military surgeon, who performed it in 1776. Investigation, however, shows that the operation had been performed already by J. L. Petit, who died in 1750: he bored through the healthy bone and evacuated decomposed pus from the mastoid cells; he also appreciated the influence of the operation, both on caries of the mastoid and on chronic disease of the ear. Jasser almost accidentally opened a carious mastoid with a probe, and was greatly shocked to find that water syringed into the opening ran from the nose; but finding the result of the operation very favorable upon the ear-disease, he proposed the same operation upon the opposite ear, which showed a chronic otorrhœa but healthy mastoid: the result on this side was a rapid cure of the chronic otorrhœa. The success in this case led to great expectations that the operation would give a means of relieving all deafness—an expectation doomed to disappointment so bitter that the operation fell very soon into disrepute, but was tried occasionally as a *dernier ressort* till Baron von Bergen, the physician to the king of Denmark, who desired it performed on himself as a relief to deafness, dizziness, and subjective noises, died from purulent meningitis, the result of perforating the brain instead of the mastoid cells.

A reference to the operation by Sir Thomas Browne (born 1605, died 1682) has escaped Prof. Schwartze. In a letter to his son he speaks of the possibility of "opening the mastoides to give vent to the tumultuous noises and winds confined therein."

After this the operation was forgotten for several decades, but was revived by successful operations in cases of caries by Forget (1849), and by von Troeltsch and Follin (1859). Numerous cases of the operation, mostly for the relief of caries of the mastoid with threatening fatal symptoms, followed, till 1861, when von Troeltsch proposed the operation, even when no cerebral symptoms were present and when the external bone was healthy, for the relief of some obstinate otorrhœas. To establish the value of the operation in the different varieties of disease of the mastoid, and the best method of performing it, was the task Schwartze set before himself by accurately recording, in chronological order, any and every case of the operation which he himself performed, together with remarks upon any peculiarities in each case.

The first article continues, after the history of the operation already mentioned, with a consideration of the anatomy, physiology, and pathological anatomy of the mastoid, which space will forbid our noticing here at length. Suffice it to say that it is a most complete discussion of these subjects, and the basis of much that has since been written, and is now so generally known.

The following articles, after the first, contain the histories of the cases, with remarks on any points of interest either in pathology or the operation, and contain very much of value to any one called upon to perform the operation. The value of the cases is greatly enhanced from the fact that the results are given not only immediately after treatment, but for a long time after—in most cases, after several years.

The last article contains the conclusions drawn from the whole series of fifty cases. Of these were:

Cured,	35	cases=70	per	cent.
Uncured,	5	" =10	"	"
Died,	10	" =20	"	"

By cured is understood a permanent relief of the suppurative process, not a restitution of the functions of the ear, which is often rendered impossible from the destruction that has taken place. The average length of treatment was from 9 to 10 months. The causes of death were:

Meningitis, 2; Meningitis tuberculosa, 1; Pyæmia, 2; Abscess of cerebellum, 1; Anæmia, 1; Epithelioma of os temporis, 1; Tuberculosis pulmonum, 2.

Of these ten cases the fatal disease was certainly wholly independent of the operation in six. In three the connection of the operation with the death is uncertain, and in one the operation was undoubtedly the direct cause of the death. Of the three doubtful cases one was otitis media, with caries of mastoid before operation, and death occurred from meningitis six weeks afterwards. The death is referred by Schwartze to an insufficient operation, which did not give free exit to the pus. The second was one of total sclerosis of the mastoid, and the operation failed to give free evacuation. Death occurred from pyæmia. The third case was one of relapse of pyæmia nine weeks after the operation. All three cases show how stringent is Schwartze's judgment against himself. The only certain death from the operation was one where, from a malformation of the mastoid, the middle fossa of the skull was opened, and the dura mater perforated by a splinter of bone, producing fatal traumatic meningitis.

The cases show, as Schwartze says, that it is in this way possible to cure the severest forms of caries, even of the petrous bone; and it is of special interest to note the effect of curing the chronic ear disease upon the general health. In one case chronic and very alarming debility was completely relieved by the cure of the ear disease; in two, the favorable effect of the operation on tuberculosis pulmonum was very marked; in one, epilepsy was permanently relieved; in two, facial paralysis was cured.

Of the cured cases the hearing became perfectly normal in 8; in 23 of the others it was much improved; in 4 absolute deafness remained, from destruction of the labyrinth by caries. The ages of the patients were: 1 to 10 years, 12; 11 to 20 years, 16; 21 to 30 years, 13; 31 to 40 years, 1; 41 to 50 years, 3; over 50 years, 5. The oldest was 78; the youngest, 2.

As indications for the operation, are mentioned acute inflammations of the mastoid cells, with retention of pus, where Wilde's incision or treatment with ice does not relieve the œdema, pain, and fever; cases in which there is intermittent swelling over the mastoid and fistulous openings in the skin, or where, as Schwartze says, nature is evidently endeavoring to effect an opening through the bone; and in these cases the operation should be done before symptoms threatening to life set in. Thirdly, cases in which there is fluctuation beneath the cutis, or the upper posterior wall of the meatus, corresponding to the floor of the antrum, or where a fistulous opening has already formed at this spot, showing a retention of pus in the antrum, the operation should be performed without hesitation, if brain symptoms are noticed. In these latter cases the operation of enlarging the fistula has been suggested, but opening the mastoid cells is the simpler and more thorough way of clearing the antrum fully of retained secretion. Fourthly, distinct caries of the mastoid, of the mastoid and tympanum, and of the osseous labyrinth, all indicate the operation, which should not be neglected, even in the worst cases, as experience shows that even the whole labyrinth may be removed by necrosis, and yet the cavity fill up with healthy granulations, which gradually ossify, and the otorrhœa is cured.

The above indications for the operation are now very generally acknowledged, but there is one class of cases where the operation is still of possible benefit. Experience has proven that caries necrotica may exist within the mastoid for years without producing the slightest external œdema, sensitiveness, or pain, the pus secreted finding sufficient exit either through the meatus or Eustachian tube. At the same time the sequestra keep up the otorrhœa, cannot be discharged, and are a continual source of danger to life. The difficulty in these latter cases is in making the diagnosis of the existence of such sequestra, for the external wall of the mastoid is perfectly healthy, and there is neither swelling nor sensitiveness. Auscultation and percussion Schwartze has found wholly unreliable, and the only certain confirmation of the diagnosis is the operation itself. Pain, fever, and a decided offensive odor to the pus, in spite of the most careful cleanliness and disinfection of the meatus and Eustachian tube, point to the existence of retained pus within the mastoid.

Opening of the mastoid, as a prophylactic measure, merely to relieve chronic suppuration of the tympanum, as has been suggested by von Troeltsch and Jacoby, to avoid possible dangers of pyæmia, meningitis, and tuberculosis, is regarded by Schwartze as of doubtful justification, as he considers the risks of the operation and the possibilities of anomalies in the formation of the temporal bone, and in the position of the lateral sinus and middle fossa of the skull, as too numerous. Symptoms of retention of pus or irritation of the brain, in these cases, however, are an indicatio vitalis for the operation.

Dividing the 50 cases, according to the above indications for the operation, we have:

I. Acute inflammation of the mastoid process, without external abscess.—Cured, 8; uncured, 1; died, 2=11 cases.

II. With external abscesses, or fistulæ—Cured, 18; uncured, 2; died, 5=25 cases.

III. With external bone healthy; operation on account of retention of pus—Cured, 7; uncured, 1; died, 3=11 cases.

Operation as an indicatio vitalis—Cured, 2; uncured, 1; died, 0=3 cases.

In the first class the one failure is referred by Schwartze to insufficient after-treatment; in the second class, one of the failures is referred to insufficient after-treatment, and one to an incomplete operation; in the third class the first failure was due to total sclerosis of the mastoid, the second to an imperfect operation.

The causes of death were, in the first class, pyæmia and anæmia; in the second class, meningitis, tuberculosis, epithelial cancer, meningitis tuberculosa, and abscess of the cerebellum; in the third class, tuberculosis, meningitis, and pyæmia. The method of performing the operation is then discussed. The hair having been removed, and the skin cleaned and disinfected, an incision is made about 1 cm. behind the insertion of the auricle from 2.5–5 cm. long, and parallel with the auricle. The periosteum is then incised and pushed back, laying bare the bone, and the bleeding checked. The cases can then be divided into two classes—those in which the bone is softened by caries, or with carious fistulæ, and those in which it is either healthy or sclerosed.

Where the bone is carious, nature has already pointed out the direction for the operation: all the softened bone should be thoroughly removed with a gouge; fistulous openings should be enlarged with the hammer and gouge till, if possible, the little finger can be inserted into the cells. If a loosened sequestrum is found, the external opening must be enlarged to admit of its removal; all fungous granulations must be removed with the sharp spoon. The wound is then cleansed thoroughly, disinfected with a two per cent. solution of carbolic acid, and a drainage-tube inserted. If the carious opening extend through the posterior wall of the meatus, as is not infrequently the case, the drainage-tube should be carried out through the other passage.

Where the bone is healthy or sclerosed, Schwartze has tried the trephine, borer, and hammer and gouge, and considers the latter by far the most universally applicable and the least likely to produce injury to the neighboring parts: he now uses the gouge entirely. The trephine, if used, should be considerably less than one-half inch in diameter; but if the mastoid is solid, as occasionally occurs, it is impossible with it to complete the operation. The disadvantage of the borer is the uncertainty of its direction and the impossibility of seeing what is being done. The gouges recommended by Schwartze vary between two and eight millimetres in width, the broader being used in the beginning of the operation, and the narrower as the deeper parts are reached, small chips of the bone being successively removed. In case of malformation of the bone there is much less risk of injuring the dura mater; in fact it has occurred to him to expose the dura mater and lateral sinus in such cases without any evil results following, although in one case a splinter of bone perforated the dura mater and produced fatal meningitis.

Much greater than the risk of injuring the neighboring parts in operations upon the healthy bone is the possibility of septic infection from the decomposed pus passing over the freshly wounded surface. The opening should therefore be funnel-shaped and larger externally.

The beginning of the opening should be made at the height of the meatus a little behind the auricle. To avoid the lateral sinus, the opening should run inwards, forwards, and downwards parallel with the meatus, and externally should be as large as possible, even twelve millimetres in height and breadth. In case the lateral sinus arches forwards and outwards, as it does in very rare cases, great care is necessary, and it might be necessary to open the antrum by chiselling away the posterior wall of the meatus.

The after-treatment is very tedious and requires considerable manual dexterity. For a few days after the operation irrigation with three-quarters per cent. salt and one to two per cent. carbolic solution, at a temperature of 100°, is necessary three times a day, afterwards twice a day. In very chronic and obstinate cases Schwartze advises also a one to two per cent. solution of sulphate of copper. In some cases it is days before the fluid washes out the inspissated pus and flows freely. The meatus must be kept free, inflation by the catheter used, granulations destroyed as occasion requires. The drainage-tube must at first be renewed daily, but when the granulations render its introduction difficult from pain, it can be replaced by leaden plugs (Bleinageln) adapted to the size of the opening and fastened in; these can be gradually reduced in size and finally omitted when it is considered safe to allow the fistula to close, which it will do in a short time. The removal of these bodies should not occur till the suppuration from the depth of the ear is reduced to a minimum and till the meatus is free from granulations and swelling.

Although in most of Schwartze's cases little febrile reaction was noticed, he recommends restricted diet and the use of the ice-bag for a time: the wound he covers with carbolized oil. In operations upon healthy bone he advises antiseptic dressings, although this will not do away with the risk of infection from the pus within the bone. The patient should be kept in bed till all fever is gone.

In closing, Schwartze calls attention to questions yet to be determined. The chief of these is whether the operation is justifiable for the relief of otorrhœas, otherwise incurable, where the external bone is healthy and where no symptoms threatening to life exist: if such symptoms are present he considers it necessary. With the exclusive use of the gouge and antiseptic dressing he thinks that in a few years the verdict will be in favor of the operation, even in these cases, but further experience is necessary to determine this point absolutely. Past experience shows that the dangers from the operation itself are pyæmia, exposing the middle fossa of the skull or the lateral sinus. Experience also shows that these two latter accidents may occur without injurious effect if the dura mater and sinus are uninjured, and they may unexpectedly occur to any surgeon from a malformation of the mastoid bone, which is, however, very rare.

DES ABCÈS MASTOÏDIENS LIÉS AUX AFFECTIONS DE L'OREILLE. THÈSE. Par HENRI GERVAIS. Paris, Jan. 30, 1879.

This admirable thesis is divided into three parts, the first being devoted to the anatomy of the mastoid region, the second to a description of the kinds of abscess occurring there, and the third part is given to the treatment of these diseases. The five anatomical layers covering the mastoid are reduced for clinical convenience to three, viz.: 1, the skin and subcutaneous cellular tissue; 2, Muscular aponeurosis and periosteum; and 3d, The mastoid apophysis. Attention is called by the author to the fact, insisted on by Tillaux, that the cartilage of the auditory canal is not a complete ring, being always deficient above and behind. Also that the cellular tissue of the mastoid region is practically a continuation of that of the auditory canal, and is hence rich in glandular elements. The candidate insists on the erroneousness of the statement that mastoid abscesses discharge through the incisuræ Santorini, since these openings are never found in the upper and back part of the auditory canal where mastoid abscesses usually discharge themselves into the external ear. The authority of Rosenthal, that the mastoid cells and the drum cavity are in communication by the fifth year, is accepted by the candidate.

Mastoid abscesses are divided by the author into extra- and intra-mastoid, and the extra-mastoid abscesses are subdivided into subcutaneous and subperiosteal. The former are developed in the subcutaneous cellular tissue, and the second variety are formed beneath the periosteum. The vast majority of mastoid abscesses are in connection with ear diseases, and of this kind alone the thesis before us treats. The subcutaneous abscesses are dismissed with a few pertinent remarks, and one case is given to illustrate the text. The chief points of interest are the cause of these abscesses and the diagnosis between them and the next variety, the subperiosteal. For the clearer explanation of this form of mastoid disease credit is given to M. Tillaux's paper, published in the Archives gen. de Méd., 1875. They are caused by what the author terms a periosteal otitis. This may propagate itself to the auditory canal, and from that part to the mastoid. In the symptomatology there is an observation of M. Selle's recorded, that in some people there is even in the normal state a false fluctuation over a limited extent, immediately above the auricle. This may lead to the conclusion that pus has formed when in reality none is there. After the opening of the subperiosteal abscess, great relief and rapid healing are usually noted, but often there may persist a fistula and various other unfortunate sequelæ, as is well known to all aurists. The reflex affections of the eye or eyes are also accurately described and well explained by the writer. In the course of a mastoid abscess, even of the subperiosteal form, the patient may complain of disturbed vision, and there are observed internal strabismus giving rise to lateral diplopia, and a contraction of the pupil and some myopia on the side of the affected ear. It might now be supposed that the patient had begun to suffer from cerebral abscess, or from a lesion of the external oculo-motor from the abscess. But these are attributed, very justly we think, to a peripheric irritation of the sensitive nerves, thus giving rise to sympathetic or reflex phenomena. In this instance the phenomena are due to an irritation of the nerves of the dura mater. These nerves are, as is well known, branches of the fifth nerve, the trigeminus. As such they are endowed with the properties of sensitive nerves, *i. e.*, they can determine reflex convulsive movements. To illustrate this point, Duret's experiments in 1877 are adduced. This observer, by irritating the dura mater of dogs by tincture of iodine and glycerine, produced contraction of the muscles of the eyes, nystagmus, with contractions and dilatation of the pupils. He also showed that mechanical and chemical irritation of the nerves of the dura mater produced intense vascular disturbances in the eyeball and in the corresponding hemisphere, and not uncommonly in both eyes and both cerebral hemispheres, thus explaining somnolence and coma in the dogs undergoing experimentation.

The strabismus in mastoid cases is attributed to a reflex contraction of the internal recti muscles, the contraction of the pupil to a contraction of the circular fibres of the iris, and the myopia to contraction in the ciliary muscle.

In concluding this part of the thesis, the following suggestive remarks are found: "This irritation of the nerves of the dura mater, which, according to M. Duret, plays a prominent part in cerebral injuries, may perhaps explain satisfactorily certain reflex phenomena observed in the course of diseases of the ear. It may be asked, are not symptoms of meningitis, so often observed at the outset of acute otitis, attributable, in part at least, to a congestive irritation of the dura mater?" Then follow accounts of ten cases of mastoid periostitis, observed by the writer and others. Case III. shows the great advantage of Wilde's incision in any case of mastoid disease, whether the bone is to be perforated or not. Case V. presents features of disease also in the membrana flaccida, and further suggests that the incision might have prevented great suffering and deeper disease had it been made sooner. The leeches seemed in this to have done no good, because applied too late, and when only the knife would have done good. The case, it seems to us, could have been terminated weeks before recovery finally took place, by a prompt incision over the mastoid, after the manner of Wilde. In the remarks immediately following this case, the vesicles appearing in the course of otitis acuta are named as something novel, but they are well known to all aurists, and have been written upon by Politzer in 1872–3. In observation XI. it seems to us the ear should have been examined more carefully and much sooner.

In beginning his comments on the intra-mastoid abscesses, the author alludes to the rarity of such diseases occurring without being connected with ear diseases. The vast majority are due to chronic aural maladies. The division of intra-mastoid abscesses accepted by the writer is that of Dr. A. H. Buck. Nothing especially new is offered in the symptomatology of this part of the thesis, though thorough familiarity is shown with what has been done by others. That part of this division which alludes to intra-mastoid abscesses in young children is very important, though of course such affections are rare in children under four or five years of age. The writer calls attention to the statistical fact that between the ages of four or five years, and fifteen or twenty years, mastoid abscesses are the least dangerous. The cases quoted in this part of the thesis show most clearly the happy results of trepanation of the mastoid process. Observation XV. shows that even in the old (the patient, a man, was fifty-six years old) the outer wall of the mastoid may open spontaneously, but it would have been more prudent to have trephined in such a case at an early date.

The diagnosis between the three forms of mastoid abscess is then considered. The first form, the subcutaneous, is easily diagnosed, and the subperiosteal is not difficult of diagnosis; the chief point of difficulty, however, is to decide whether, in a case of mastoid disease, the abscess is seated wholly in the periosteum or in the mastoid cells.

It is stated that Toynbee and Duplay considered, as a distinctive feature of intra-mastoid abscess, the existence of a circumscribed swelling and redness of the skin, confined to the upper and back wall of the bony part of the auditory canal; but the candidate is guarded in accepting this as distinctive. He considers the signs drawn from the mastoid region as of much greater value. "In intra-mastoid abscess the pain is usually dull and profound, and pressure is less painful than in periostitis of the mastoid. The swelling begins at the mastoid region, and remains there; the auriculo-mastoid furrow is preserved, or perhaps it may become more pronounced. Here the swelling assumes an œdematous rather than a phlegmonous character, and fluctuation appears slowly."

The existence of cerebral symptoms in such cases would also tend to prove the existence of an intra-mastoid abscess. As is well known, the diagnosis is easily made in a large number of cases; but very often the surgeon is in grave doubts, either because the patient has come too late, and presents confused symptoms of two forms of mastoid abscess, or because the symptoms of neither intra- nor sub-periosteal mastoid abscess are sharply defined. Very often, too, in young subjects, the malady assumes a typhoid appearance, and is treated as typhoid fever. The prognosis of suppurative inflammation of the mastoid cells is, of course, considered very grave.

Treatment.—After discussing the possibility of preventing mastoid abscesses, the thesis devotes chief attention to the treatment of intra-mastoid abscesses. The highest importance is here attached to the treatment of purulent otitis media, which is the chief cause of this bad form of mastoid inflammation. Here occurs the remark, which seems worthy of being presented in the writer's own words, as illustrating a new and highly desirable tone in theses for the doctorate in medicine. He says: "The indifference, not only of the laity, but even of numbers of physicians, in regard to aural diseases, is indeed at once singular and very sad. The greatest solicitude is evinced for the slightest affection of the eyes, but discharges from the ear are, as a rule, completely neglected. Very often there is shown more than indifference, for very many people think that aural discharges are salutary emunctories, and that it is harmful to arrest them. This may arise from the sudden stopping of discharges so often seen in purulent otitis just before some grave and deeper lesion becomes manifest. But here it is unknown to the majority of people that the discharge ceases, either because there is some mechanical obstruction to its flow, or because a subacute otitis or some general affection has arisen."

The various forms of operation for opening the mastoid cavity are discussed; great familiarity with all the best known ways being shown.

The writer acknowledges the delicacy of the undertaking, but shows how necessary, as well as simple, the operation is, when all the indications, as well as the anatomy of the region, are fully understood.

The point for penetration preferred by the writer is that recommended by M. G. Désarennes, viz.: at the "slight depression at the posterior root of the zygomatic apophysis." After the antrum is laid open the recommendation is given to syringe through the perforation in the outer mastoid wall, in order to see whether communication exists between the mastoid cells, the tympanum, and the Eustachian tube. But it is not stated whether the injected fluid should be warmed or not; yet we presume no one would inject cold fluids into such cavities. Daily syringings with detersive fluids are then recommended. An elaborate bibliography is appended to the thesis.

The entire thesis shows great industry, as well as a marked interest, on the part of the writer, in the subjects which he has chosen to write upon, and every page shows also the necessity, as well as the success, of operating on the mastoid cells when inflamed.

ON DEAFNESS, GIDDINESS, AND NOISES IN THE HEAD. BY EDWARD WOAKES, M.D., LOND. Pp. 140. London, H. K. Lewis, 1879.

THE material of which this little work is mostly composed appeared from time to time in the medical journals, and has been noticed freely in the current otological literature of America. The writings of Dr. Woakes are well worth being collected, and they are now presented to us in a convenient and attractive form. Referring to the preface, the author at the outset informs us that in his researches he found very scant assistance in the aural books as regards their explanation of the etiology of giddiness and noises in the head, all referring these symptoms to some subjective state of the auditory nerve.

It is with a feeling of relief that we thus find some one stoutly contesting the orthodox belief on these points, and at the same time making an attempt to clear up the ambiguity which has heretofore pertained to the subject. The author's scheme is best stated in his own words: "About ten years ago, while considering the association of neuralgia with herpes, and the analogous phenomena attending wounds of nerves, the author became aware that the numerous instances in the economy, the local connections of vaso motor innervation, are such that given tracts of tissue, not otherwise connected, are thereby habitually kept in nutritive correlation one with another. Between any two areas thus correlated so intimate is the relation, that any departure of one of them from its ordinary state is immediately appreciated by a corresponding set of nutritive changes in the other. The explanation of this mutual interdependence between the respective, often widely separate regions, is found in the association of their afferent and efferent nerves with a given sympathetic ganglion. Thus, these organs were seen to assume co-ordinating functions not usually attributed to them." Although the theory of vaso-motor innervation, as applied by Dr. Woakes in elucidation of the physiological processes concerned in the production of tinnitus and vertigo, must as yet be received with caution, we are convinced that his endeavors will assist in the work of preparing the way to a more comprehensive understanding of questions pertaining to otology, which have been heretofore involved in obscurity.

The first chapter of the book enters into a consideration of the ear complications which occur in dentition—a complication which to some extent has long been recognized, but which heretofore has not received the attention from aurists that its importance demands. There is, however, at this time a more intelligent interest in this subject than has heretofore obtained.[1]

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[1] Vide Rest and Pain, Hilton, p. 46 et seq., New York, 1879; and Clinical Lectures upon Inflammation and other Diseases of the Ear. Cooper, London, 1878.

The second chapter is devoted to the ear complications in exanthemata. In this particular field also there appears to be a revival of interest among otologists of late years,[1] but greater interest is needed before physicians and the public realize the importance to life and hearing of an early recognition of this prolific source of aural disease.

The third chapter is on ear-cough, etc., and the author finds here his most forcible illustration of reflex action. Chapters four, five, and six are on giddiness, vertigo, and tinnitus, together with their treatment.

After a careful reading of these pages, one is impressed with the fact that Dr. Woakes has done much towards the elucidation of the subject to which he has applied the theories drawn from late physiological observations. That he has in some instances gone further than is warranted by well-confirmed facts, is natural, and should excite favorable criticism only when the amount of good accomplished is considered. The explanations of tinnitus and auditory vertigo are instances of conclusions which are to be accepted with caution, although they are more satisfactory than the convictions on this subject by which they have been preceded. As far as these theories of nervous relationship are to be accepted, they are surely the forerunners of a better system of aural therapeutics than has heretofore obtained.

An example of the author's therapeutics in acute inflammation of the middle ear, arising from a "definite vascular condition, usually, though not necessarily, one of dilatation, originating at a greater or less distance from the scene of vessel disturbance, and propagated by vaso-motor nerves in the manner described," is found in his recommendation for this condition; that after the local abstraction of blood, "drop doses of tr. aconit., B. P., should be given, because it diminishes the heart's action and lessens the sensitiveness of the peripheral nerves." This latter idea is not quite in harmony with the recorded physiological action of the drug. Schroff, who has, perhaps, experimented physiologically with aconite more thoroughly than any one else, says[2] that aconite produces pain in the temporal, frontal, and the supra-orbital branches of the trigeminus. Ott[3] says: "It causes in the whole region of the trigeminus a peculiar pain, which at first is vague, but at length becomes constant."

We do not wish to throw doubt on Dr. Woakes's assertion that aconite will sometimes control pain in this region, as personal experience enables us to confirm it; how it does so we have not been able to satisfactorily explain, and we are not quite prepared to accept the explanation given by Dr. Woakes.

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[1] Vide Buck: Transactions of the International Medical Congress, Phila., 1876; and Spencer: The Ear in Exanthemata, Transactions of the Medical Association of the State of Missouri, 1878.

[2] Lehrbuch der Pharmacologie. Wien, 1856, p. 532 et seq.

[3] The Action of Medicines, Phila., 1878, p. 109.

The seventh and final chapter contains supplementary observations on the co-ordinating functions of the sympathetic ganglia, and their influence in determining the symptoms of disease: herpes, neuralgia, trophic nerves, etc. The wide range of application of the vaso-motor influences, in explanation of morbid phenomena, affords an opportunity for elucidating many anomalies outside (strictly speaking) the field of otology, of which Dr. Woakes has availed himself by extending his researches in various directions. Although recognizing fully the advantages to specialism of a liberal expansion in discussion, our space will not admit of a further notice of the book at this time.

REVIEWS.

STUDIES IN ACOUSTICS.—1. ON THE SYNTHETIC EXAMINATIONS OF VOWEL SOUNDS. WILLIAM HENRY PREECE AND AUGUSTUS STROH. *Royal Society Proceedings*, No. 193, 1879.—The method pursued by Messrs. Preece and Stroh in this series of very ingenious and valuable investigations was the reverse of that followed by Messrs. Hewing-Jenkyn and Ewing, Mayer and others, who directed attention to the analysis of the tracings upon the foil of the Edison phonograph. That the phonograph is at its present best an imperfect speaker is evident to any one who has experimented with one, and the reasons for this imperfection in the reproduction of speech are not far to seek. The analysis of the record made by the phonograph disc, therefore, must but imperfectly represent the audible speech elements.

The authors proposed, therefore, obtaining, or constructing, as perfect sound records as seemed possible, and using the curves mechanically prepared for the audible reproduction of the sound represented. The first object was to find a disc which would vibrate to the finest shades of sonorous vibrations, and which would be free from those characteristic and "personal" partials which are nearly inseparable from all vibrating discs, and which interfere with their true action. This was finally accomplished by using a stretched membrane of thin rubber, rendered rigid by a cone of paper. This membrane was adjusted to a telephone mouth-piece, and to the centre of the membrane was attached an extremely fine glass tube, filled with aniline dye, which served as a pen. (The attachment of this pen is similar to that of the stylus of the Maury improved phonautograph.) The band of paper on which the pen made its tracing was moved by a mechanism similar to that used in the Wheatstone automatic telegraph apparatus, at a speed which could be varied at will from one to eighteen inches per second. Run at a slow speed, this instrument acts as a logograph, recording the air pressure in front of the lips, and at a high speed as a phonautograph, recording the sonorous vibrations of the membrane. At a medium rate of speed a combination of the logographic and phonautographic curves is obtained, as in the membrana tympani phonauto-logograph. Graphic representations of curves corresponding to the vowel sounds, to the study of which this paper is confined, as drawn by this instrument, accompany the paper.

The next step was the construction of a very ingenious "synthetic curve machine," which, by means of a series of toothed wheels, actuating a marking lever, produced these vowel curves mechanically, illustrating the composition of vowel sounds by the combination of the primes and harmonic upper partials. It also illustrated the production of simple tones by simple harmonic curves, and compound tones by simultaneous action of several simple tones. One interesting fact worthy of mention, arising from the operation of this machine, is that curves can be so constructed as to give a stereoscopic effect. One curve is drawn simple, and the other, drawn in the same line—at the proper distance from it to fit a "stereoscope"—is made compound, by the addition of a partial of low amplitude. The result of the combination of these two curves, by the eye in a stereoscope, is to produce a perspective effect.

Having mechanically produced vowel curves, the next step was to mechanically produce the vowel sounds themselves, by superimposing partials upon a given prime. This was ingeniously accomplished by preparing a series of metal discs, the peripheries of which were cut in an exact copy of the several curves produced by the "synthetic curve machine." These discs, each of which represented one partial, were fixed on the same axis, which could be rotated by means of a crank, at a given velocity. By depressing a key a spring could be brought into contact with the edge of each wheel, and thus, on rotating the axis, set in vibration. The vibrations of these springs were conveyed by means of thin cords, and intermediate linking to a diaphragm of ebonite. Each spring could be depressed separately or simultaneously, the diaphragm vibrating to the resultant effect of all the vibrations of the springs. In this manner notes and chords can be sounded.

By conveying these vibrations to the receiving disc of a phonograph, an "automatic phonograph" results. In this improved instrument the diaphragm is so arranged that it can be shifted from one to another of the discs, cut at the periphery in exact accordance with the curves produced by the "synthetic curve machine," and the sounds produced by the different curves can be readily compared. A number of combinations of curves, representing each vowel sound, with certain variations of the partials, were also cut upon the peripheries of similar discs. These discs were then placed upon the axle, and the sounds most resembling the vowel sounds of the human voice were easily recognized.

One interesting result obtained from the experiments with the "automatic phonograph," which has also been observed in experiments with the Edison phonograph, is that, by varying the pitch, the vowel sounds can be shifted, namely, the curve producing *oo* at a low velocity, becomes approximately *o* at a higher velocity, *o* similarly becomes *ah*, *ah* becomes *ā*, and *ā*, *ēē*.

The curves arrived at synthetically do not differ very materially from those arrived at analytically by Helmholtz. They principally differ in the prominence of the prime. But the prime can be dispensed with altogether.

Curves produced by the synthetic machine, compounded of the different partials without their prime, show that there exist beats or resultant sounds.

A vowel sound of the pitch of the prime may be produced by certain partials alone, without sounding the prime at all. The beat, in fact, becomes the prime.

Another point of importance considered by the authors is the true theory of the loudness of sound, it being advanced by them that the loudness of the sound does not depend upon the amplitude of the vibration only, but also upon the quantity of air put into vibration; and, therefore, there exists an absolute physical unit in acoustics analogous to the unit of quantity of electricity or quantity of heat, and which may be called the quantity of sound. In fact, in the automatic phonograph, the diameter of the sounding disc ought, if it were possible, to vary with the pitch of each note, to produce equal intensity of sound. That the authors are now engaged in pursuing this inquiry into the consonantal sounds gives promise of still further and equally valuable contributions.

EXPERIMENTS WITH EDISON'S PHONOGRAPH.—OSCAR WOLF: *Archives of Otology*, VIII., No. 1, p. 58.—In this paper the author first describes the instrument and then proceeds to compare the mouth-piece and disc with the attachment of the stylus to the human membrana tympani and external auditory canal, suggesting the employment, if possible, of a fine animal membrane in place of the ferro-type or paper disc, a suggestion which has previously been carried out by Mr. Edison and others in this country, with good results, and to investigate the character of the indentations upon the tin-foil.

The results of these examinations, as illustrated by the woodcuts which accompany the paper, correspond with those made by Prof. A. M. Mayer, and Prof. Jenkyn and Mr. Ewing. When the vowel A is sounded in a bass voice, the indentations are much broader and deeper than those made by the same vowel sound in a treble voice. The vowels E and I impress much smaller forms than either A or O, and the S sound, the highest tone of speech, produces the smallest and most numerous impressions. The consonants B, K, T, F, when spoken alone, gave, on account of their apparently weak tone intensity, no definite sound figures, while in connection with vowels they were given back from the instrument distinctly. In the sound R, on the contrary, the membrane is thrown into strong vibration, the point making large and tolerably deep, almost round, impressions. The author also notes the increase in pitch of tones recorded as returned when the rapidity of revolution of the cylinder is increased, as already observed by Prof. C. R. Cross and others.

While the subject-matter of this paper is, in effect, a repetition of experiments already recorded by other observers, it is of value in so far as it serves to further draw the attention of the student to an added means of investigation, and as showing that the phonograph may be made of use in experiments in comparison with the valuable work of the author on the hearing of consonant sounds, as given in his book entitled "Speech and the Ear."

TRANSMISSION OF THE HIGHER TONES BY THE TELEPHONE. EDWARD HAGENBACH: *Annalen der Physik und Chemie*, 1879, 1208, p. 407.—These experiments to determine the telephonic transmission of high musical tones by means principally of tests with König's rods are in a measure a repetition of similar experiments made by the reviewer in 1878, the results obtained being much the same. Following mention of the theory of the action of the Bell Telephone as educed from the experiments of DuBois-Reymond, L. Hermann, H. F. Weber, Helmholtz, and others, the author describes his tests with tuning-forks and König's rods, giving preference to the latter, since the question is then not one of hearing the tone more or less, but one of hearing or not hearing. The rods used were those of the original scale as prepared by König, ten in number, the longest giving a tone of 3192 v. s., the shortest a tone of 65,536 v. s. Having first determined the upper limit of hearing at 35,000 v. s., the telephones were then interposed, and the upper limit of audibility was found to be much lower, at least two octaves, the difference representing the obstacle presented by the telephones. The localization of this obstacle in the electric conduction, in the magnet, or in the iron disc, was determined by interposing resistances which altered the strength and not the limit of transmission, and by changing the discs, which latter experiment alone had an effect upon the limit of transmission.

An important observation in this connection was the omission to transmit certain tones in the upper limit of the scale, explainable by the influence of the individual tone of the disc: the discs transmitting most readily those tones which more nearly accorded with their individual tones.

THEORY OF BINAURAL AUDITION. ANTON STEINHAUSER: *Philosophical Magazine*, March and April, 1879, pp. 181 and 261.—In this valuable paper the author discusses and presents at length the observations which he has made, and which form the basis of the theory of binaural audition. As a full report of the experiments made and the results obtained would require nearly the reproduction of the paper, the general results which are contained in the concluding remarks only are submitted.

The whole 360 degrees of the region of binaural hearing divides itself into three portions: in front, the region of direct hearing; at the two sides, the regions of mixed hearing; and at the back, the region of indirect hearing. Under favorable circumstances, and without moving the head, we are, in consequence of our binaural hearing, able to decide from the sensations of sound in which region of hearing the source of sound is situated. An exact knowledge of the direction in which the source of sound is situated, and an estimate of any motion executed by it, are only possible so long as the source of sound remains in the direction of direct binaural hearing.

If, on the other hand, the source of sound is situated either in the region of indirect or in that of mixed binaural hearing, we may arrive at an exact knowledge of the direction in which it is situated, by turning the head while we seek to bring the source of sound: 1. Into the region of direct hearing, and preferably, into the direction of best binaural hearing.

2. Onto the boundary of two neighboring regions of hearing. Since the direction of this boundary is known to each individual, the direction of the source of sound when brought into coincidence with this direction is also known. This auxiliary means offers in many cases the advantage that it only requires a slight movement of the head. If, for example, the source of sound be in the direction of indirect hearing, a very slight movement of the head suffices to bring it onto the boundary between the regions of indirect and of mixed hearing.

3. Into the known direction of best monaural hearing. This happens when, in doubtful cases, we wish to decide whether the source of sound is situated in front or behind. For, if we turn the head about a vertical axis, according as the source of sound is situated before or behind, the intensity of the sound will increase in the ear that is turned forward or backward respectively, since by the movement of the head the source of sound is brought more nearly or even quite into the direction of best hearing for one of the two ears.

The angle which the surfaces of the pinnæ make with the line of sight (equivalent β) may, in certain circumstances, exercise no inconsiderable influence upon binaural hearing. Since this angle is not always alike in different individuals, but may differ within certain tolerably wide limits, the consequences which the largeness or smallness of that angle may involve, are summarily enumerated.

In accordance with the theory given the larger the angle β is:

1. The wider will be the region of direct binaural hearing.
2. The smaller will be the region of mixed binaural hearing.
3. The better and more distinct will be hearing in the line of sight.
4. The larger will be the region of indirect binaural hearing.
5. The less certain will be the estimation of direction in the region of direct binaural hearing; and lastly,
6. The greater will be the possible difference in the total intensity with which a sound is received for the various positions of the head.

The circumstances adduced in the first three points may be regarded as the advantages; those in the last three as the disadvantages entailed by relatively increasing the value of the angle β.

In conclusion, attention is drawn to the fact that estimates of direction may be made in many cases, in which, according to the preceding theory, the faculty of so doing is strictly wanting to the organs of hearing. Often the most unimportant and apparently inconsiderable things serve to suggest a particular position as that of the spot in which the source of sound is situated, so that, then, this power of finding the direction is falsely ascribed to the ear.

HISTOLOGICAL STUDIES OF THE MEMBRANOUS LABYRINTH, ESPECIALLY OF THE COCHLEA OF REPTILES AND OF BIRDS. P. MEYER: *Thèse de Strasbourg*, 1876. Review by E. Schwartze in the *Revue des sciences médicales*, Jan. 15, 1879. —Meyer's article seems to demonstrate that the vestibule and the semicircular canals are for the reception of noises, while the cochlea is adapted to perceive music.

The theory granting to the auditory ciliated cells the greatest importance, seems to be the true one, according to the investigations of this author, which confirm the views of Hensen and Ranke. The otoliths and membranous coverings are held to be a damping apparatus.

THE AQUÆDUCTUS COCHLEÆ IN MAN. WEBER-LIEL: *Monatschrift für Ohrenheilkunde*, No. 8, 1879.—The aquæductus cochleæ is usually described as a simple passage serving merely for a vein which collects the blood from the cochlea and conducts it to the jugular vein. By means of injections, the method of using which is fully given, Weber-Liel now claims that the aquæductus cochleæ contains no vein but forms a free canal, lined with a continuation of the dura mater, which unites the scala tympani of the cochlea with the intracranial cavity. Also he finds that from just behind the bulb of the jugular vein, or else from the sinus petrosus inferior, near the bulb of the jugular, a vein passes into the entrance of the aquæduct and then enters a separate osseous canal, parallel with the aquæduct, and finally connects with the scala tympani by its own separate opening from one-third to one-quarter millimetre distant from the opening of the aquæductus proper.

THE ACOUSTIC APPARATUS IN THE ORGAN OF HEARING OF THE HETEROPODS. CLAUS: *Archiv für Mikroskopische Anatomie*, Bd. xv., p. 341.—The writer of the present article published, in a previous volume (xii.) of the *Archiv für Mikr. Anatomie*, an account of the minute anatomy of the organ of hearing of the pterotrachea, based upon investigations made both upon fresh specimens and upon those which had been kept in preservative fluids. Shortly after its publication, Prof. J. Ranke, of Munich, sent to the same journal (vol. xii., pp. 565–569) a communication, in which he disputes the correctness of Claus' description, and gives what he believes to be the true anatomical relations of the organ of hearing in the pterotrachea. The points of difference between these two authorities are thus briefly summed up by Claus:

1. According to Ranke, the large central cell is surrounded by only four

symmetrically placed hearing cells. According to Claus, there is a large number of such cells, arranged concentrically around the central cell.

2. These four outer hearing cells are surrounded, according to Ranke, by a ring-shaped ganglion, consisting of several rows of small ganglion cells into which the fibres of the acusticus enter. Claus fails to find any such ganglion. On the other hand, he believes that the forms described by Ranke as ganglion cells correspond to the concentrically arranged hearing cells of the thickened sensory epithelium, into which the fibres of the acusticus enter.

3. The comparatively broad space between the central cell and the outer hearing cells is occupied, according to Ranke, by an intermediate plate, which is perforated in the centre to afford space for the central cell. Claus, on the other hand, fills the space referred to with four large cells, to which he ascribes the function merely of supporting or isolating structures.

With regard to these points of difference, Claus says that he has repeated his investigations, using for the purpose fresh specimens treated with solutions of osmic acid and chloride of gold, and still finds that his original description is correct in every particular. Prof. Stricker and Prof. C. Hasse, to whom he submitted his microscopic preparations, confirm the description given by him. Prof. Hensen, who had had an opportunity, while in Naples, of examining the organ of hearing of the pterotrachea coronata, writes as follows to Claus: "So far as I was able to verify them, I found your statements with regard to the relations of the cells and cilia of the acoustic papilla, and the course of the nerves, exactly in accordance with what I myself found in the preparations which I examined. In all those points, therefore, in which Ranke's description and yours differ, I consider Ranke's account to be erroneous."

ON THE TREATMENT OF OSSEOUS TUMORS OF THE AUDITORY CANAL. DR. VICTOR BREMER, of Copenhagen: *Annales des maladies de l'oreille, etc.*, Paris, 31 Dec., 1878.—In this short paper the writer gives his experience in the treatment of an exostosis in the auditory canal of a Danish naval officer. There were bony growths in both canals, the largest being in the right, and here we suppose the operation was performed, although there is no express statement as to the side to which the operation was confined. The right canal was entirely occluded by an osseous growth situated 22 mm. from the mouth of the passage, and extending from the upper, the posterior, and the inferior walls.

The writer first tried a fine flexible saw, but this could not be properly worked, and was abandoned. He then used a pair of scissors, and succeeded in cutting off a small piece of the tumor. The hemorrhage was abundant, and *cold water* was used to restrain it. The patient, now having been under chloroform for half an hour, was resuscitated and the operation stopped.

During the rest of the day *cold* applications were kept to the ear, and with morphia the patient slept that night. An abundant suppuration followed. As further use of the scissors was not permitted, the patient was again chloroformed, and Dr. Bremer concluded to try the dental engine, as suggested for these cases by Dr. Mathewson, of Brooklyn. He says that "after employing this instrument a few moments he dared not continue, as it seemed to him to act with too much force, and he feared he would injure the membranes of the drum." He then returned to the scissors, and in a short time he had the good fortune to perceive he had cut through the tumor, and upon sounding he touched an *elastic body*. The hemorrhage was considerable, and the treatment was as before.

The suppuration was copious and granulations were numerous, but the ear was kept clean with warm-water injections and the granulations were touched with nitrate of silver. For fourteen days the canal was kept open by means of conical pieces of laminaria digitata, which were put in place in the early morning and removed at noon. Each piece was provided with a string by which the patient could remove it if the pain should become *insupportable*.

In five weeks the hearing was restored. When the healing was complete, it was found that an oblong opening four millimetres long had been made in the tumors, and that the membrana tympani could be seen beyond.

The writer concludes that the dental engine can be used only in the tumors near the mouth of the canal.

ON EXOSTOSES WITHIN THE EXTERNAL AUDITORY MEATUS. WILLIAM TURNER, M.B.; F.R.S.: *Journal of Anatomy and Physiology*, xii., part 2, p. 200.—Prof. Turner describes the occurrence of exostoses in two crania examined by him. The first was an adult male skull obtained at or near Pisaqua, Peru, and was an excellent specimen of the artificially deformed Peruvian skull, the frontal bones sloping backwards in an almost straight line from the glabella, and the occipital bone also having a very decided backward inclination. Both external auditory canals were nearly occluded by hard ivory-like exostoses. On the right side two of these exostoses were present, one almost blocking up the orifice, arose from the anterior wall, by a constricted peduncle; it was pea-like in form, and possessed a diameter of nearly three-tenths of an inch; the other, more elongated in shape, had a broad base of attachment to the anterior wall, and was more deeply seated than the pisiform exostoses. Two exostoses were also situated in the left meatus. One about the size of a pea arose by a broadish base of attachment from the anterior wall; the other, the size of a small shot, arose from the posterior wall towards its lower part. The two exostoses almost touched in the middle of the meatus, so that in the living person, when the integument was in place, the passage must have been quite blocked up. The exostoses, both on the right and left sides, grew from that part of the wall of the meatus which was formed by the auditory plate of the expanded tympanic ring.

In the adult skull of a flat-head Chenook Indian from the district of the Columbia River, Prof. Turner found the right external auditory meatus partially occluded by a broad-based exostosis, which was elongated from without inwards, and grew from the posterior wall formed by the tympanic plate. On the left side a similarly shaped, though smaller exostosis, also sprang from the posterior wall; and much deeper in the meatus a linear-shaped exostosis could be seen, which from its position was evidently attached to the same wall near the posterior border of the membrana tympani.

Both of these crania having been greatly altered in shape by artificial compression, the question naturally arose if the growth of the exostoses had been induced by the pressure to which the bones of the head had been subjected in infancy. There was, however, nothing in the appearance of the skulls to bear out this supposition. Notwithstanding the deformity of the vault of the cranium, and a somewhat backward inclination of the squamous temporal, the zygoma and parts around the meatus preserved their natural form. Prof. Seligmann, quoted by the author, found five cases of exostoses out of six artificially deformed crania examined, while the author found only the two cases above cited out of seventeen artificially deformed crania of North and South American Indians examined by him. In three of these crania, however, the auditory meatus, though without exostoses, was modified in shape, being flattened from before backward. This deviation from the normal contour of the canal, Prof. Turner is, however, not inclined to ascribe to the artificial elongation of the crania; and in this respect, and also in regard to any influence which the compression of the skull in infancy may have upon the occurrence of exostoses, he agrees with the opinion expressed by the late Prof. Jeffries Wyman.

In several specimens of Peruvian skulls not artificially deformed Prof. Turner observed the narrowing of the auditory meatus, and especially in one case, a specimen from a tomb at Pachacama, the entrance into the right external meatus was narrowed to a vertical slit. There would thus appear to be, in the author's opinion, a tendency on the part of the aboriginal inhabitants of the American continent to possess modifications in the configuration of the external auditory passage.

The paper of Prof. Turner is an exceedingly interesting one, and with the large number of aboriginal American crania now in the possession of museums, and in private collections in this country, it is to be hoped that the subject will receive from other observers the attention which it merits.

CONTRIBUTIONS TO THE PATHOLOGICAL ANATOMY OF THE EAR. BURCKHARDT-MERIAN: *Archiv für Ohrenheilkunde*, xiv. Bd., drittes Heft, March 18, 1879.—Four cases of dissections of the ears are fully described. In the first, a girl, aged nineteen, had had chronic otorrhœa since childhood on the left side. Distinct symptoms of meningitis set in, and the autopsy showed circumscribed basilar meningitis backwards from the chiasma, and confined to the left side. A carious fistula communicated through the bone with the antrum and the superior petrosal sinus (probably in the course of the petroso-mastoid vein), and there was a thrombus in this sinus, with phlebitis. The tympanum was in a state of chronic inflammation, and filled with polypoid growths. The antrum measured 11mm. by 8mm. The most interesting appearance, however, was the total absence of any mastoid cells, the bone remaining in its rudimentary condition, so far as the cells were concerned, although it had apparently fully developed in size, a condition already described by Schwartze.

The second was one of chronic tympanic inflammation on the left side, with caries of the tympanum, antrum, mastoid cells, and the osseous wall of the lateral sinus. There was necrosis of a large part of the membranous walls of this sinus, with partial thrombosis. The autopsy showed meningitis tuberculosa, caseous pneumonia, and pyo-pneumothorax. In the third case there was caries of the tympanum and antrum, with external opening over the mastoid; caries of the parietal bone. Death from peritonitis tuberculosa. The fourth case was one of chronic otorrhœa, necrosis of the antrum and squamous portion of the temporal bone, with death from peritonitis tuberculosa. In the three latter cases the direct connection of the ear disease with the fatal result cannot be determined. In the first case it was undoubted. The three last cases, although offering nothing new, are of interest as contributions to the pathological anatomy of tympanic inflammation.

AUDITORY VERTIGO. J. HUGHLINGS-JACKSON: *Brain*, April, 1879.—Two cases are reported, in one of which ocular movements occurred during a paroxysm of auditory vertigo, and in the other there was, following the discharge of a heavily-loaded gun near the right ear, a tendency to walk to the left side, and noises in the right ear. The former case, when first seen, had had attacks of auditory vertigo for four years, with deafness and noises in the left ear. In this case the attacks began by the left eye "being full of specks," when things in the room began to pass to the right, the same things passing continually in the same direction. He *next* became giddy, and vomited, but did not lose consciousness. Dr. Hughlings-Jackson was fortunate enough to witness one of these attacks whilst conversing with the patient. Becoming suddenly ill, the doctor led him to a sofa, as he seemed apparently unable to stand. He half reclined on the sofa, and looked very ill, saying he was giddy.

On looking at his eyes, about two minutes after the attack began, the pupils were observed to be very large, and the two eyes were in movement. Each eye was partially and very slightly rotated to the right, in frequent jerks from left to right. The attack lasted ten minutes. His pulse was not irregular. Towards the end of the paroxysm he perspired, his temperature in the axilla remaining normal. There was no sickness. The patient was benefited by large doses of quinine. In less than two months he was again seen, and four grains of quinine three times a day were prescribed, which benefited him, but did not prevent a recurrence of the attacks.

An examination of the ears demonstrated the presence only of such a condition of the tympanic membrane as pertains to catarrhal inflammation of the middle ear.

As regards the cause of paroxysms, which are a result of persistent or slightly varying changes in the ear, the suggestion is made that the attack is determined by diminished resistance of nervous centres during general enfeeblement of health. Sydney Ringer suggests that one factor in the development of the paroxysm of migraine is a diminished resistance of nervous centres.

Patients who are the subjects of chronic auditory vertigo are often a very little giddy, and scarcely perceptibly unsteady in gait, until below par, when they are worse. When, however, they are invigorated by a well-spent holiday, the symptoms may pass off altogether. The artificial invigoration by quinine may cure, or cure temporarily, by enabling the centres to resist the "irritations," starting from the ear. The occurrence of noises in the ear after excessive doses of quinine, may perhaps be owing to exhaustion, consequent on over-stimulation, and thus not be a fact discrepant with the opinion that large doses of quinine increase the resistance of nervous centres.

"*By a very superficial process of reasoning we might suppose that salicylate of soda in small doses might be a useful remedy in auditory vertigo ; for in the doses given in rheumatic fever it causes great noises in the ear.*" (Italics ours.)

The second case of auditory vertigo reported was that of a medical gentleman, who was made deaf in his right ear by the discharge of a heavily loaded gun. Immediately after the accident he discovered that he was unconsciously disposed to walk and reel to the right side; and he has never yet found himself wholly free of this tendency. Noises were set up in the right ear almost immediately, and have continued ever since without one moment's intermission (unless when asleep). Much of the time they have been singularly distressing, and have been accompanied, occasionally, by alarming cerebral symptoms, severe headaches, etc.; in fact, he has never been really comfortable in his head since the concussion was experienced. He is unable to concentrate his mind on any subject, his memory is bad, and, as he himself expresses it, the symptoms worry him a bit; and "although I am, as a rule, very buoyant and easy-going, I fancy there is something that may develop into coarse brain disease."

An examination of the ears in this case, it may be stated, failed to discover any anomaly which could explain the pathological condition.

POST-MORTEM APPEARANCES OF THE ORGAN OF HEARING, IN A CASE OF PERSISTENT HALLUCINATIONS OF HEARING. GELLÉ: *La Tribune Médicale*, 30 Mars, 1879.—M. Gellé reported to the *Société de Biologie*, at its meeting on the 15th of March, 1879, the results of a post-mortem examination which he had recently made of the organ of hearing of an insane person well advanced in years, who, during her lifetime, suffered from constant hallucinations of hearing. At the time of her death the patient was an inmate of the Salpêtrière hospital, under the care of M. Luys, one of the attending physicians. As a first step in the examination, which was made twenty-four hours after death, M Gellé opened the superior or vertical semicircular canal, and also exposed to view the contents of the vestibule. All these parts were found to possess a normal appearance and consistence, and the mobility of the stirrup seemed to be unimpaired. The trunks of the facialis and acusticus were next examined and found to be perfectly natural. The middle ear, with the membrana tympani, ossicles, Eustachian tube, and mastoid cells was also found to be free from any evidence of disease. The external auditory canal was normal. The examination included both ears, and both seemed to be perfectly healthy. While, therefore, no trace of disease could be found in any part of the organ of hearing, the walls of the carotid artery were found to have undergone certain changes at its bend in the temporal bone. These consisted in thinning at certain spots, with dilatation, while at other places there was slight induration with a corresponding degree of atresia. On the convex surface of both cerebral hemispheres, however, M. Luys found pathological changes of sufficient importance to account for the persistence of the hallucinations referred to.

A CASE OF MASTOID ABSCESS FOLLOWING SUPPURATION OF THE INTERNAL EAR; ARTIFICIAL PERFORATION OF THE MASTOID PROCESS. J. W. WAUGHOP: *The American Journal of Medical Sciences*, April, 1879.—A case of acute purulent inflammation of the middle ear, arising from cold, and which was not completely relieved when a discharge was established on the third day. There was much swelling of the auricle, and "a black sphacelus, the size of a dime, on its anterior superior margin, which came without apparent cause." "The general health was evidently not very good, being impaired by the malaria of Fort Walla Walla, where she had recently been living." The patient was in the sixth month of pregnancy. "By the fifteenth day, under the daily use of the syringe for washing out the collected matter, both from the meatus and through the Eustachian tube, the severity of the symptoms had passed away, and the patient was able to sit up a little. But from the first there was more or less tenderness about the mastoid process, which would not yield to treatment —blisters, poultices, anodynes—and by the twenty-fourth day, notwithstanding the discharge from the ear was copious, the skin over the mastoid had become swollen, tense, and red, and the pain intolerable." An incision made the full length of the process down to the bone gave relief for a few days, when the pain returned with great severity. With a Brainard perforator a hole was made into the mastoid three-sixteenths of an inch in diameter, on a level with the upper margin of the meatus, and about half an inch behind the auricle, the site of the operation being in the old incision. The operation was followed next day by a discharge of pus from the mastoid cells, and the patient experienced relief. The discharge from the mastoid finally ceased in about nine weeks.

The discharge from the ear was profuse, and always consisted of laudable pus; it continued from May 3d to August 7th, and then ceased. The ear was washed out daily with warm water, to which soda was usually added, and by putting a rubber ring on the nozzle of the syringe to prevent the outward flow of water, the remaining pus and mucus was forced by the pressure of the water through the Eustachian tube into the pharynx. After the washing, carbolized glycerine, solutions of tannin, white precipitate, and other astringents were thrown into the ear, and the orifice kept closed with a bit of cotton. After the lapse of two months, when the pains and aches of the ear and parts adjacent had largely passed away, to stop the secretion of pus French chalk was puffed into the ear with a syringe, so as to cover the secreting surfaces.

Blisters upon the mastoid process, it is to be feared, are in such cases as the above likely to invite an extension of destructive inflammation to the mastoid cells, for we should remember that there is always a danger of such a result, do what we may. The absence of busy medication, such as is sometimes practised in these cases, is to be commended. As regards syringing from the meatus externus to the pharynx per tympanum and Eustachian tube, that method of treatment was recommended by Schwartze, and accepted by Hinton in cases where, as a result of aural disease, unabsorbed products remained in the tympanum, retained there by the presence of an intact membrane, a preliminary operation in these cases being the perforation of the membrana tympani. In acute inflammation of the middle ear scarcely any imaginable condition would warrant the forcing of a solution of soda, or other fluid, through the drum cavity by pressure in the external meatus.

AURAL SURGERY IN GENERAL PRACTICE.—*The British Medical Journal*, January, 11, 1879, brings forward, through a well-informed correspondent, some favorable arguments in favor of requiring some knowledge of aural surgery at the pass examinations of those who intend to go into general practice.

The great body of general practitioners are said to be very ignorant as regards ear diseases—a condition due simply to a want of attention to the subject. The results of neglected ear diseases are only too well known to every aural surgeon, and are more dangerous to the life of the patient, to say nothing of discomfort, etc., than are the affections of any other organ of special sense.

The great frequency of these diseases, especially in childhood, and the advantage of treating them early, are subjects on which it is unnecessary to enlarge. Considerations such as these, it is said, render it very advisable that every surgeon should be able to diagnose and treat the commonest forms of ear-diseases, and to recognize those cases in which further advice is necessary. This desirable result will not be obtained until some knowledge of this department is required of every candidate for a license to practice.

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NOTES.

Authors whose papers are not mentioned in the Bibliographical Index will confer a favor by informing the Editor of the omission, and by giving the title of the paper, the date of publication, and the name of the journal in which it appeared, in full, for future insertion.

Medical officers of the United States Army, stationed on the frontier, in Indian territory, will confer a favor by sending the results of any observations which they may see fit to make, upon the size and contour of the external auditory meatus in native Indians, to Dr. Samuel Sexton, 12 West 35th St., N. Y. Suitable acknowledgment of such contributions will be given in any future use which is made of them.

The aural questions to be discussed at the next annual meeting of the Ophthalmological and Otological Section of the British Medical Association, to be held at Cork, Ireland, on the 5th of August next, are the following: 1. The Therapeutic Value of the Intra-tympanic Injection of Medicated Fluids in the Catarrhal Affections of the Middle Ear. 2. Tinnitus Aurium.

Blank record-books, for the registration of deaths, have been sent to every physician and surgeon in the United States, by the Superintendent of Census, Prof. Francis A. Walker. If these records are kept faithfully, as it is of the greatest importance that they should be, much valuable information will be elicited. Thus, for example, we shall be able to learn for the first time how many deaths take place annually in this country from diseases of the ear.

SOUND VIBRATIONS AND THE TELEPHONE.

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SINCE the invention of the speaking telephone there have been, both in Europe and in America, a considerable number of persons who have been dissatisfied with the ordinary explanation of its action as due to the correlation of ordinary sound vibrations of an inductive substance and magnetism, these two resulting in electricity, and such persons have sought to explain the phenomenon by supposing some molecular action different in kind from those with which we are familiar. I have not been able to find any expression of opinion as to how this so-called molecular action differed from ordinary sound vibrations, but have seen a good deal that has led me to infer that the structure of a compound sound vibration is not understood by those who declare for the molecular action; and again it does not appear to have occurred to any of them that a molecular action, such as they argue for, implies a form of energy hitherto unknown, and is therefore without a name.

Among the forms of energy the laws of which are known, we name: 1st. Mechanical motion, which consists in the displacement of the centre of gravity of a mass of matter. 2d. Heat, which consists in the internal vibration of a molecule without displacing its centre of gravity. 3d. Electricity, which consists in the internal motion of a molecule, the form of the motion being probably one of rotation. 4th. Magnetism, the result of rotating molecules, which stands to electricity as gravitation does to a raised weight. 5th. Chemism, which consists in the selective agency of molecules, by which exchange of energy is determined among them; and lastly, Gravitation. We have no knowledge of any others, and if by the term *molecular action* is meant some form of energy different from the above forms, then plainly we have a new form of energy which should have a new name. But, before a new force is summoned, it will be well to see if the familiar forms are not competent to do everything that has yet been observed in telephones. Consider, first, the magneto-telephone as a transmitter. Sound vibrations made in the air impinge upon an inductive plate of iron, which makes it to vibrate backward and forward in the field of a magnet, and currents of electricity result if there be a proper circuit. Now, it has been inferred that the inductive plate does not vibrate—at any rate, not in the ordinary way, since, when the plate is very large, as it has sometimes been made, it still continues to act inductively as *if it did vibrate*, but owing to the size or the mass of it, it has been thought that it *could not do so* to an extent sufficient to produce the observed effects; that is, that the plate does not perform anything like a pendulous vibration. In order to understand what must take place, it will be necessary to call to mind the structure of a sound wave in air and other media. Suppose, then, a simple sound wave in air with a wave length of one foot. If such a wave when formed could be made visible and kept stationary, it would be seen to consist of a dense part and a rarefied part, and if there were one hundred molecules in the length of it these would appear a little closer together by about the one-sixtieth or the one-eightieth of their ordinary distance, which represents the one-half of the actual displacement of one molecule by the movement called a sound-wave. The displacement of a molecule of air for an ordinary sound-wave is something like the one-millionth of an inch. Its direction of motion is to and fro, in the direction the wave travels, and if one could observe the motion of a single molecule it would be seen to vibrate about 1,100 times per second, and all that would be seen would be simply this to and fro movement, as if it was the bob to a very short pendulum. It is purely a mechanical motion of a molecule, but not what is implied by the term molecular motion or action, as manifested in what is called heat, for there is a change of position of the whole molecule with reference to other bodies, whereas in heat the molecule has not necessarily any motion of progression in any direction, its motions being purely internal. Let such a moving molecule impinge upon another molecule and it will give up a part of its energy of motion to it, and the amount so given up will depend upon the elasticities of the two molecules. If they were both perfectly elastic and of the same mass, the whole energy would be given up; the first would be brought to rest and the second would move in the same direction with the same velocity. Such condition, however, we can never practically have, and a molecule impinging upon another which has a greater mass will receive back a part of the energy it has imparted, and will rebound from the second, and this we call reflected motion for large bodies and echo for molecules. Suppose that a molecule moving under the influence of a sound vibration impinges upon a molecule of iron which is placed in front of the pole of a magnet about which is a coil of wire with its two ends in contact; such forward motion as the iron molecule would receive would increase the inductive effect of the magnet and induce a current of electricity in the wire, the energy of this current depending upon the external energy of the moving iron molecule, which depends solely upon its velocity, not upon a distance traversed. This energy finds its algebraic expression in the formula $E = \frac{mv^2}{2}$, and taking the molecule of iron as the unit of mass, the energy of the molecule will at any time equal $\frac{v^2}{2}$. Velocity is simply a *rate* not a distance, and this is important to bear in mind in this connection. What has so far been applied to a single molecule of air and of iron in the field of a magnet may be applied at once to a stratum of air in the same phase of a sound wave, and a stratum of iron perpendicular to the lines of force of a magnet. Each air molecule will impinge upon its corresponding iron molecule, and the stratum of iron will move toward the magnet in obedience to the impulse; each separate molecule reacting upon the magnet will contribute to the energy of the current, and the entire energy now will be $\frac{Nv^2}{2}$ when N is the number of molecules, or, what is equivalent to it, the mass. In practice we never can have a single stratum of molecules nor anything approaching it. The thinnest film of water we can produce in the soap-bubble must be several molecules in thickness in order to possess tenacity enough to maintain the form of the bubble; but the thin disk of iron that is ordinarily used for a telephone plate must be many thousands or millions of molecules in thickness. It remains then to see how this can modify the foregoing.

The velocity of sound in iron is about sixteen times greater than it is in air, and consequently the sound wave which is one foot in length in air would be about sixteen feet long in iron, while the amplitude of the motion of the molecules would be as much smaller as its relative density is greater, that is, the actual displacement of the molecules must be many times less in iron than in air when the energy of the motion is the same. We may consider the common telephone plate as a thin section of a bar of iron sixteen feet long, and having the same diameter as the plate; then the whole of this section will be in the same phase of the sound wave when it traverses the bar, and consequently every molecule in it will be slightly displaced, and, as a mass, it will move to and fro for every wave that traverses the bar. But if the section was .01 of an inch thick, there could at no time be more than $\frac{1}{19200}$ of one wave within the section ($16 \times 12 \times 100 = 19200$), and 1,100 such vibrations per second would cause the section to change its phase 21,120,000 per second ($19200 \times 1100 = 21,120,000$).

In the case of the bar this vibrating section gives up its motion to the section of adjacent molecules, while in the case of the section in the field of a magnet, a part of the energy would be imparted to the air behind it, and a part to the magnet pole in front of it, which would at once be metamorphosed into a current of electricity. When a series of like vibrations is imparted to a body, if the latter be inelastic, the energy of the vibrations is all absorbed by it, and appears as heat; if it be elastic, the vibrations will be conducted to every part of it, and the amplitude of vibration will be greater or less as the mass and the form of it vary. If the mass be large, the amplitude of vibration will be simply proportionate to the originating vibration; if it be small, the amplitude will be irregular, and most of the energy will appear as heat by metamorphosis; while, if the form and mass be such that the velocity of the wave in it bears a simple ratio to the wave length, then we have the phenomenon that is called resonance in some cases, and sympathetic vibration in others. For instance, the stem of a vibrating tuning-fork, held upon a large mass like a table, has its vibrations rapidly diffused, and is heard plainer because the large surface in contact with the air is giving off at every point its own motion, and hence the air has a greater amplitude. Let the stem be held upon a small mass like a knife or a pencil, and the latter may be felt to vibrate, but the sound is still weak, and is expended as heat. If the stem be placed upon a tube of proper length, at once the sound is much strengthened, because the length of the tube bears the ratio of $\frac{1}{4}$, $\frac{1}{2}$ or $\frac{1}{1}$ to the wave length. In this case we have resonance or sympathetic vibration.

Now, a small body, whatever may be its form, will receive sound vibrations, and be made to move as a mass more or less synchronous with the original vibrations, of whatever period they may be. The larger the body is, the more the interference from want of synchronism; but in each and every case the movement is simply one of the displacement of molecules, and, in all cases where the body through which a sound wave passes, consists of a series of molecules, as is always the case practically, no two adjacent molecules can be in precisely the same phase of the wave, and therefore, when, as in the case of an iron disk in front of the magnet, the plate is acted on by sound vibrations, each of the molecules will be in its own phase, and will modify the energy of the magnet in its own way; and hence interferences and neutralizations must result, and the greater the number of molecules so acting, the greater will be the loss of energy as represented in the magnetic changes. The plate cannot, theoretically, have a simple pendulous movement, synchronous with the initial vibrations, even for a simple sound, much less for one which consists of the highly complex system of tones which constitute the voice of an individual. In every case of sound propagation there is a mass moving with the velocity of the sound wave, though in the case of simple rectilinear propagation, the mass moving is not the same in any two consecutive instants, and this moving mass is not to be confounded with the molecular movements of its parts, for the absolute space traversed by a molecule is very slight.

It is the energy of this moving mass that is transformed into an electrical current through the mechanism of the magnet and its appropriate coil; hence the very great electro-motive force developed. The energy of a vibrating mass is proportional to the square of the velocity, or, what is equivalent to it, the square of the amplitude of vibration; and if we compare two vibrating bodies with each other, both having the same amplitude of motion, and one making twice as many vibrations per second as the other—that is, one an octave above the other—the higher sound will be found to have four times as much energy as the lower one. Furthermore, it has been the common experience that higher sounds are better rendered by a telephone than lower ones, and the overtones in one's voice are not unfrequently much better heard than the fundamental sound, which is in accordance with the simplest dynamical principles.

When the prong of a tuning-fork is struck under ordinary conditions its period of vibration is uniform, and we say that it makes a definite number of vibrations per second. If, however, the prong be brought into the neighborhood of a magnet, and be made to approach and recede from a pole, the rate of vibration must be lowered, for the prong cannot move away from the magnet with the same velocity as it approached it, on account of the increased inductive effect from nearness to the magnet. The fork must then have its pitch lowered. The fork has lost energy, which finds expression by the heating of the magnet in an open circuit and by a current of electricity in a closed circuit. This loss of energy speedily brings the fork to rest; and if the same conditions obtain in a properly mounted induction plate, the loss of energy in this way for a single vibration only prepares the way the better for the reception of the subsequent vibration, of whatever sort it may be, and thus is a real advantage in the transmitter.

Among the transmitters of the *variable-resistant* type founded upon the Reiss mechanism of 1861, the sound vibrations simply vary the distance between the surface molecules of the two terminals, of whatever sort they may be, and are at the surfaces substantially what they are within any sounding body—molecules in various phases of a single sound vibration; that is, a greater number of molecules are in contact at one part of the vibration than at another; and as the conductivity varies as the number of surface molecules in contact, we have a complete explanation of the variable current from such devices.

Turning to the receiver, we have an instrument for the convertibility of electricity of variable strength into sound vibrations. Now, the immediate mechanical action of the current is first made manifest in changing the length of the magnet. If this action is sudden and transient, then the longitudinal molecular displacement will be similar to what it would be if the magnet was struck on one pole by any object, and the disturbance will travel to an indefinite distance—a rod or a mile, if the magnet was so long—as a sound vibration, and with the same velocity in the magnet as in an ordinary bar of iron or steel. A series of such pulses occurring within the numerical time limits of audibility will result in sound which may be heard. Some persons, hearing such sounds from a magnet, have straightway concluded that the molecular movements resulting in sound were not properly sound movements; but a sound vibration is in any case a molecular disturbance that is propagated in a conductor with a velocity which depends upon the elasticity and density of the conductor. It is entirely immaterial whether it originates in this way or that way, by the stroke of a hammer, by the firing of a gun, or by the induction of a current of electricity upon iron.

In the latter case the audibility of the sound would depend upon the amplitude of the molecular displacement in the air, which would in turn depend upon the magnitude of the surface of the body which imparts its own motion to the air, precisely as with a tuning-fork. Hence, if an electro-magnet of any form receives transient electric energy, the click of the magnet may be heard by one holding it at his ear. If the magnet rests *upon* any resonant surface, the click may be heard at some distance; and if the pole of the magnet has an armature of iron upon it, this will act as a resonating surface; so will a piece of wood or a piece of any metal. If, however, the armature of iron does not quite touch the magnet, but is within inductive reach of it, the armature will be attracted toward the magnet as a mass, and if it be free to move, it will begin to move toward it. But it is inferred that, because the molecules that make up the disk of a telephone receiver are all of them within the reach of induction, the inductive disturbance among the molecules follows some other law than one of sound vibration. Instead of the disk of iron which has very generally been considered so essential to the efficiency of the speaking telephone, let a piece of iron wire, two or three inches long, be fastened to the middle of a mica, or wood, or paper diaphragm of the ordinary size, mounted in the ordinary way, and let the free end of the wire be brought near to the pole of an electro-magnet, say an ordinary sounder or relay, which is on a closed circuit, with an ordinary carbon transmitter into which one is talking. An ear applied to the aperture of the disk will hear what is said with as much distinctness as with any of the receivers with which we are familiar. If, also, the ear be applied to the armature of the sounder, there will not be the slightest difficulty in hearing what may be spoken at the transmitter; and if the string of a string-telephone be tied to the armature, and the latter brought down closely to the poles of the magnet, the ear at the opening of the string-telephone will hear with great clearness all spoken words, which shows—in the first instance of the wire and mica diaphragm—that ordinary sound vibrations traverse the wire and give up their energy in the cavity for the ear; and in the second case, with the common armature, that the latter is vibrating, as any small body will do for a tuning-fork—that is, acts as a resonator, while the string-telephone attachment simply transmits the same vibrations to a cavity giving a greater advantage to the ear by concentrating the waves.

There remains one more form of receiver with which some remarkable phenomena, difficult to explain, are connected;—I refer to the sounds that are heard from the so-called microphone. When a current of electricity traverses carbon or any other conductor, it is heated, and that heat immediately does work by expanding the conductor. The amount of expansion is proportional to the current. If two molecules of carbon be conceived to be the terminals of an electrical circuit, as soon as they come in contact the current passes and they become heated, and two molecules that are heated and free to move will bound away from each other, and if other molecules free to move are in their neighborhood, they will impart their motion to them and then return together like other elastic bodies; in other words, such heat-motion will instantly be transformed into a sound vibration, and, if repeated sufficiently often, will be heard as a continuous sound.

In each case, therefore, when the observed phenomena are correlated, there is no residuum. There is no need to summon a new form of energy when the old forms are quite competent to effect all the changes.

SOME RECENT OPINIONS CONCERNING THE DEVELOPMENT OF THE EXTERNAL EAR PASSAGES.

BY DAVID HUNT, M.D.,

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THREE years ago the writer read a paper before the International Otological Society, in which the opinions concerning the development of the external ear passages, published by von Baer fifty years earlier, were held to be in the main correct; this was the first statement of this opinion in recent times, and in direct opposition to current views on the question. Since then Dr. Moldenhauer[1] and Dr. Urbantschitsch[2] have written upon the same subject; their articles contain so much of interest in agreement and in opposition to the views which I had previously stated, that it seemed as if a short comparison of the different opinions might be of interest.

Dr. Moldenhauer's account of the development of the external ear passages is as follows: At an early stage of development four little nodules (colliculi branchialis externi) arise on the first and second branchial arches; the cause of their formation is probably the obstacle which the heart offers to the longitudinal growth of the arches. The first and second pair of arches soon unite in their median portion at a point situated between the anterior and posterior pairs of colliculi. Upon examining the interior surface of the branchial arches he finds an oblong elevation arising from the inner surface of the superior maxillary process of the first arch; this elevation increases from above downward until it abruptly terminates at the first cleft; it is bounded by two furrows, which below are lost in the first branchial cleft, but above, the anterior furrow runs into the mouth cleft (*i. e.*, the angle between the superior and inferior maxillary processes of the first arch), while the posterior gradually disappears; the anterior furrow is called by Moldenhauer the "sulcus lingualis," the posterior the "sulcus tubo-tympanicus;" the eminence which they border upon he calls the "colliculus palato-pharyngeus." He describes the Eustachian tube as a continuation of the sulcus tubo-tympanicus, the middle ear as the dilated extremity of this sulcus, the membrana tympani as a section of the base of the first branchial arch cut off by the extension of the sulcus tubo-tympanicus into the substance of the arch, the meatus externus as formed by the development of the colliculi branchialis externi and the increase in thickness of the side of the face (Gesichtswand).

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[1] Morphologisches Jahrbuch, 8tes Bd., 1stes Heft.

[2] Mitheilungen aus d. embryol., Institut d. k. k. Univ. in Wien (reviewed in the Archiv f. Ohrenheilkunde, 12ten Bd., 5tes Heft).

These observations of Moldenhauer agree in the main with those published by Urbantschitsch as the result of his researches upon the embryo of the rabbit, although each observer seems to be independent. Thus Urbantschitsch describes the Eustachian tubes, in the embryo, as two lateral involutions of the mucous membrane of the pharynx. Urbantschitsch denies the generally received statement that the first branchial cleft is divided into the Eustachian tube and meatus by the union of the median portion of the first and second arches forming the membrana tympani; he describes the cleft as uniting in its whole length, leaving finally a little circumscribed furrow on the external surface which is lined by the outer blastodermic membrane. The outer extremity of the Eustachian tube, which, as he supposes, forms the middle ear, is not, according to Urbantschitsch, connected with the first cleft nor with the mass of tissue which occupies its site, but is an involution extending towards the basis of the first branchial arch. The tissue which covers the termination of this involution is the embryonic drum membrane, and three layers of tissue may be demonstrated in it at this time. Concerning the auricle, Urbantschitsch says that it has no connection with the branchial clefts, but that it is an entirely independent formation.[1]

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[1] This account is condensed from the review in the Archiv für Ohrenheilkunde, 12ten Bd., 4tes Heft.

Urbantschitsch mentions the agreement of his view of the formation of the Eustachian tube with that of von Baer; how close it is will be seen from the following translation of von Baer's description: "An outgrowth of the pharynx lined with mucous membrane grows towards the ear; this forms the Eustachian tube and the middle ear; the outgrowth occurs, at the time that the first cleft closes, in the following manner: After the closure of the cleft *a furrow is seen on the inner surface* (see Moldenhauer) that marks the position which it occupied; the upper extremity of this furrow extends to form the Eustachian tube, the remaining portion is obliterated.

"The auricle is formed from a little ridge of skin like that which forms the eyelid; the otic vesicle does not reach the surface, but an involution extends from the little prominence, which is to form the outer ear, towards the site of the otic vesicle; this is the meatus externus."[1]

Moldenhauer does not, like Urbantschitsch, refer to von Baer's priority, although, as is readily seen, that portion of the sulcus tubo-tympanicus of Moldenhauer which forms the Eustachian tube agrees with von Baer's description of the pharyngeal furrow which forms the same structure; in fact it is the same. Von Baer, like Moldenhauer, was observing the development of the chick, but von Baer wrote fifty years earlier. Although Moldenhauer's nomenclature is new and a little confusing at first, it is very evident that after the sulcus tubo-tympanicus loses itself in the first cleft, any description of the transformations which the cleft undergoes must include the lost furrow, if we feel obliged to consider it as an independent structure. For my own part, I cannot think that this is necessary; indeed, doing so may lead to mistakes, for the colliculus palato-pharyngeus, as near as I can make out, is, in the main, the inward projection of the rather swollen root of the first branchial arch. Now, if this is so, the sulcus tubo-tympanicus, which loses itself in the first cleft, is not a simple furrow that bounds a little projection upon the superior maxillary process of the first arch (as Moldenhauer describes the colliculus palato-pharyngeus), but rather a groove which bounds the vertebral end of the root of the first arch, and the elaborate nomenclature not only confuses these really simple relations, it also covers an error.

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[1] **Entwickelungsgeschichte der Thiere, 2te Theil, S. 116.**

As far as the formation of the Eustachian tube is concerned these publications of Urbantschitsch and Moldenhauer add to the confirmation of von Baer's opinion, which I had already stated before the First Congress of the International Otological Society in 1876;[1] three independent observations, agreeing in a matter of so much interest, as far as the physiology and pathology of the ear are concerned, will, we trust, reopen this question, which has appeared for so long a time to be settled. In the end, we believe that the wonderful exactitude of von Baer's observations will be still further confirmed by its settlement.

In regard to the formation of the auricle, meatus externus, and membrana tympani, the views of Moldenhauer and Urbantschitsch differ from those which the writer has published; they agree in stating that the Eustachian tube extends upward and backward until it nearly reaches the surface, and that the tissue and integument covering the extremity of the tube formed the membrana tympani. I have described the membrana tympani as a portion of connective tissue included between the meatus externus and the Eustachian tube of the embryo; naturally a result of my statement would be the deduction that there is no appearance of a drum membrane until after the formation of the meatus externus. The full force of this difference of opinion may be seen by consulting the illustrations accompanying Moldenhauer's article (loc. cit.). Fig. 25, plate viii., shows a section of the head of a chick at the ninth day of incubation; fig. 27 of the same plate shows a like section at the twelfth day; in fig. 25 the meatus is described as a slight depression of the integument; a section of tissue located above this depression is described as the membrana tympani; in fig. 27 the meatus is shown as a deep fissure that did not exist at the ninth day, and the tissue adjoining this fissure is described as the membrana tympani; that the latter figure is correctly described is proven by the relations of the cartilaginous columella, but if this figure is correctly described, the former cannot be. What, then, shall we make of the membrana tympani as shown in fig. 25? It is evident that the relations agree with the descriptions of both Moldenhauer and Urbantschitsch; the tissue described as the drum membrane covers the end of the involution which forms the tube and consists of the three layers, mucous, epithelial, and connective, that constitute the membrana tympani; it is in about the position which that structure should occupy. An explanation of these appearances is obtained by studying closely the formation of the middle ear cavity and the auditory ossicles; we find that it is not the terminal portion of the primary Eustachian tube which gives origin to the middle ear, but that a more median portion of the involution, lying rather under and outside of the cartilaginous labyrinth, dilates to form this cavity; we see an absorption of connective tissue around the forming ossicles and labyrinth that seems to favor the dilatation of the tube. In making sections of pig embryos, at various stages of development, less than three-fourths of an inch long, I was for a long time puzzled by such apparent sections of the membrana tympani as Urbantschitsch and Moldenhauer have described; it was only by studying the process upon embryos representing various stages of growth, to a full inch in length, that I was able to convince myself that the terminal portion of the primary pharyngeal involution really gives origin to the mastoid cells, and that the layer of tissue covering it in the young embryo does not form the membrana tympani, but the outer wall of the mastoid process. Some negative evidence upon this point is furnished by discrepancies in Moldenhauer's account of the formation of the meatus externus. He at first describes the formation of the meatus as due to the development of the colliculi branchialis externi. Further on he says: "The drum obtains the deep situation that it afterwards occupies, not by means of a continual sinking of the surface into the side of the face (Gesichtswand), but in an opposite manner, viz., by the side of the face pushing itself outward and growing thicker, so that thus gradually a pocket is formed between the elevations at the bottom of which the drum is situated." The relation of the inferior maxilla to the meatus is somewhat in opposition to the above view. Meckel's cartilage lies in nearly the same plane as the drum; it forms in the inferior maxillary process of the first arch; and it seems scarcely possible that an elevation of the face, sufficient to account for the depth of the meatus, could occur and leave the inferior maxillary process of the first arch, so important a part of the face, in undisturbed relation to the drum membrane and the depths of the meatus. But this objection is trivial compared with the positive evidence which is furnished by studying the transformations which the elevations, called by Moldenhauer the colliculi branchialis externi, undergo in the embryo of an animal furnished with an auricle; the process by which they form the auricle may be easily traced in a series of pig embryos of from five-eighths of an inch to an inch in length without making sections; it is also readily seen that the fossa between the colliculi merely results in the formation of the concha, and that the slit or furrow bounding the root of the first branchial arch is a continuation of the first branchial cleft upward, that divides the site of the auricle into two distinct portions whose imperfect fusion results probably in the human embryo, in that little depression or slit so frequently obvious in the helix; it will be seen that the meatus externus is comparatively late in its appearance, and that, as von Baer described it, it is an involution of the integument; upon the pig embryo it is also seen that this involution occurs from the anterior inferior portion of the cavity of the concha. Indeed, fig. 12, plate 8 of Moldenhauer's article, exhibits a section of this involution, just as von Baer describes it, but there is no relation between this portion of the figure and Moldenhauer's text.

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[1] Report of the First Congress of the International Otological Society, p. 100 et seq. See also Am. Jour. of Med. Sciences, Jan., 1877, and Boston Med. and Surg. Jour., Oct. 18, 1877.

The opinion concerning the manner of formation of the stapes, which I expressed in 1876 before the International Otological Society, has been confirmed by Löwe[1] and Gruber.[2]

The connection between the formation of the cartilaginous labyrinth and auditory ossicles on the one hand, and that of the cavities of the middle ear and mastoid cells on the other, is very interesting; it seems as if the absorption of the surrounding connective tissue, caused by the chondrification of the labyrinth and ossicles, is the direct cause of the formation of these cavities.

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[1] Bericht der Munchen. Naturforsch. Versam. 1877, p. 343.

[2] Schenck's Embryolog. Mitth. Vienna, 1878, p. 167 (see Archives of Otology, Vol. VIII., No. 1).

There is one point in Moldenhauer's paper that concerns us in a general way only, but it affords so apt an illustration of certain tendencies in the study of embryology that I cannot refrain from noticing it; I refer to Moldenhauer's account of the causation of the little elevations upon the first and second branchial arches which he calls the "colliculi branchialis externi;" these he thinks are due to the obstacle which the heart opposes to the longitudinal growth of the arches. If we call to mind the gelatinous consistency of the embryo at this stage of development, and the great mechanical effect upon the branchial arches which might follow the rapidly changing curvature of its anterior portion, we shall be puzzled, I think, in attempting to conceive how these slight irregularities upon contiguous borders of the first and second arches could result from an opposition to their longitudinal growth; the first pair of arches meet and unite before the heart is sufficiently developed to oppose their growth, and the extremities of the second pair fuse with the already united ends of the first pair; as the heart develops, its cephalic end appears to lie in the throat, but not in a manner to oppose the future development of the branchial arches, indeed it rather protects them during the period of their closure. Moldenhauer's attempt to use the mechanical style of reasoning of His, leaves us with an idea of the heart opposing the growth of the branchial arches as a rock might oppose and distort the growing roots of a tree; we lose sight of the fact that at this stage of growth both heart and branchial arches are myxomatous structures, rapidly growing, not independently, but with a rhythm, so to speak, that pervades all the delicate structures of the embryo. A slight mechanical force may produce great disorder if it affects the force governing nutrition abnormally; but within the bounds of this process, most of our attempts at simple mechanical explanations are, like most of those which His has produced, elaborate folly.

A glance at the pathological anatomy of the external ear passages may furnish a few facts that will lend additional interest to the more recent views concerning their development.

The most common congenital malformations of the meatus externus are stenosis and atresia. They are often associated with malformations of the auricle, and the common cause is supposed to be arrest of development. They are often found in connection with cervical fistulas, cleft palate, and other results of defective development of the bones of the face (V. Handbuch der Path. Anat., E. Klebs, 6te Lief., Gehörorgan). Schwartze quotes Virchow's opinion that disturbances in the process of closure in the first branchial cleft cause these affections of the meatus; but it is apparent that this explanation involves a contradiction. Cleft palate and hare-lip, as traces of arrest of development of portions of the superior maxillary process of the first arch, are easily understood, but in what manner a defect or arrest of the process of closure of the first cleft could cause *atresia* of the meatus, if it is but a section of the first cleft, is difficult of comprehension. According to the views of development of these parts in vogue, and upon which Virchow bases his opinion, the result of an arrest of development or a defective closure of the first cleft should be absence of the membrana tympani; in other words, a defect here analogous to cleft palate or hare-lip would be a more or less perfect communication between the site of the auricle and the interior of the pharynx. There is no analogy and no reason by which we can account for the relative frequency of atresia of the meatus, if we adopt the generally current opinion, established by Huschke, concerning the development of the external ear passages. Moldenhauer's view as to the formation of the meatus also leaves us without a definite idea upon this point. The process which, as he supposes, results in the formation of the meatus—viz., "the growing thicker of the side of the face," is constant and stands in no relation to atresia or stenosis of the meatus. According to our view of the development of the meatus, we should expect to find it associated with just those defects which so often accompany it, and which we know result from arrest of development. The meatus is an involution of the integument, and the involution occurs after the branchial clefts are closed. Congenital aural fistulæ may be due to defective closure of the first cleft, but an arrest of development can only result in absence or stenosis of the meatus, since this passage is produced by an active process, an involution of the integument, as von Baer stated more than fifty years ago. Simple observation of the surface of a series of pig embryos between one-half an inch and one inch long, will convince any observer of the truth of our description of the formation of the auricle, and will furnish strong presumptive evidence of the same in regard to the formation of the meatus, which careful section cutting will confirm. A difference of opinion in so simple a matter would have hardly been possible if all observers employed the same manner of preparing the embryos and observed a sufficient range of stages of development. While I have employed most of the reagents used for hardening, the greater number of specimens have been prepared in Müller's fluid, carefully washed out in alcohol and water, and hardened in alcohol.

Congenital absence of the membrana tympani is a very rare, indeed doubtful affection. The Eustachian tube forms at an earlier period than the meatus, and it gives origin to the middle ear cavity whenever the labyrinth and ossicles form; the outer wall of this cavity represents the membrana tympani. Moldenhauer states that the position of the drum membrane is at first perpendicular; but this idea is a result of his mistake in regarding that layer of integument covering the termination of the Eustachian tube as the membrana tympani. It is, in fact, the first indication of the mastoid process. The nearly horizontal position of the drum membrane in the lowly developed skulls of cretins is in harmony with the history of its development. As it is at first formed by the Eustachian tube overlapping the meatus, its position is nearly horizontal, and, as the skull develops, its position approaches the perpendicular.

Congenital malformations of the Eustachian tube are very rare, probably partly on account of the very early stage of development at which the simple involution of the pharyngeal mucous membrane occurs.

THROAT DEAFNESS ASSOCIATED WITH PARESIS OF THE PALATO-TUBAL MUSCLES.

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MY attention was first directed to the probable relationship between loss of power in the palato-tubal muscles and some forms of deafness by the fact that, in two recent cases of operation for *cleft palate*, in which I was compelled to myotomize very freely in order to secure the proper adaptation of the edges of the wound, a considerable degree of impairment of hearing remained after recovery with complete rectification of the defect for which the operation was performed, and which deafness, though it did disappear, did so only gradually.

This fact attained more important dimensions to my mind on observing some cases of cophosis in which the ear itself, so far as it was open to inspection, was quite healthy, but where there was a more or less degree of paresis of the soft palate, either unilateral, or affecting both sides equally. In some of these cases deafness did not exist, but only distressing noises in the ears, for which in fact the patients sought relief, being quite ignorant of any loss of muscle-power in the region of the palate. Thus, one began to get away from the notion of tubal catarrh as the invariable concomitant of throat-deafness, and to attach more and more importance to the neuroses of this region in their relationship to aural defects. That such neuroses are more frequent than is generally supposed, and that they afford very early indications of exhausted nerve-power pointing to excessive physical or mental strain—that they are frequently the direct cause of deafness or tinnitus, while the ear symptoms are the only intimation of their presence recognized by the patients—are some of the practical bearings of the subject which I propose to bring forward in this paper.

It is necessary at this point to recall the anatomical facts that the intrinsic muscles of the ear, the tensor tympani and stapedius, as well as those of the Eustachian tube and palate, are with one exception (the salpingo-pharyngeus) supplied by the same nerves, or branches of the same.

Thus, the tensor tympani gets a branch from the otic ganglion, as does also the tensor palati. Indeed, these two muscles are to be viewed as parts of one and the same structure: they are anatomically connected in many subjects, though not in all; while the circumstance of their being innervated from the same ganglion constitutes an arrangement for co-ordinating their action. The stapedius is supplied by the seventh, as also is the levator palati through the vidian, but the latter muscle also receives a branch from the vagus. The salpingo-pharyngeus is supplied by the glosso-pharyngeal nerve, while the remaining tubal muscle, the internal pterygoid, which assists in opening the upper and back part of the tube, is supplied by the third division of the fifth, and is therefore intimately associated with the otic ganglion.

The suggestive fact about these anatomical considerations is, that the muscles which act on the drum-head and ossicles to bring about the state of tension in the conducting media best calculated to receive and propagate vibrations of sound, are associated in their nerve-supply with the muscles whose function it is to open the tube and so secure the proper entry of air within the cavity of the middle ear, without which the accommodation of the drum-membrane could not take place. Further study of this subject will probably indicate that it is to the paretic state of the tensors of the palate and drum-head alone that the symptoms are in the main to be referred, and it is the consequences of their inactivity which will chiefly concern us in this inquiry.

Passing to the clinical aspect of paresis of the palate and tubal muscles, and bearing in mind these facts of identity of nerve-supply, it becomes clear that the existence of the palatal paresis which we can see and investigate enables us to predicate with considerable exactness the presence of a similar loss of power in the intrinsic muscles of the ear also, which we could not otherwise detect. The combination of both these conditions of paresis not only interferes with the ventilation of the tympanic cavity, but is destructive of those acts of accommodation already spoken of as essential to the accurate perception of sound-waves. We have thus brought before us a distinct phase of cophosis, which I venture to affirm will be found to be a very common one if looked for, and the recognition of which will prove a great gain in the differential diagnosis of the various forms of deafness. It has the further advantage of being for the most part under the control of the aurist, if properly treated.

It will of course be understood that I do not refer to that form of impairment of muscular action seen in this region as the result of follicular inflammation, or of hypertrophic thickening of the fauces, in which the submucous tissues are infiltrated and stiffened so that even the act of swallowing is attended with a marked effort. These lesions are in their essence inflammatory: they interfere with the operation of opening the cartilaginous mouth of the tube by clogging the movements of the muscles destined for this purpose, just in the same way as the excursions of the vocal cords are curtailed by an inflamed state of the mucous and submucous tissues overlying the muscles which act upon them. Persons who smoke and drink largely often exhibit this sort of throat, accompanied with more or less deafness, the latter symptom being due quite as much to the inability of the muscles to open the tube when their contraction is thus mechanically impeded, as to a catarrhal state of the lining membrane of the tube, though in many cases both conditions coexist.

The following are concomitant *signs* of throat deafness associated with paresis: inspection of the drum-head affords only negative indications—if previously healthy—though some degree of collapse of the membrane due to insufficient ventilation of the tympanic cavity, will most likely show itself. There will be no difficulty attending the injection of air through the Eustachian catheter, as the feebly innervated muscles oppose no obstacle to its forcible direct admission in this manner, but the patient cannot usually perform the Valsalvian inflation. Such a state of things is calculated to give rise to some difficulty regarding diagnosis, and I suspect many cases of the kind referred to have been relegated to that limbo of obscure causes of deafness—progressive middle ear disease. At any rate, I am sure they were so disposed of by myself till I came to see them from another point of view. This is secured by inspecting the fauces. Even here there may not be much to arrest the attention. The palate veil simply presents a very dependent appearance, so that the uvula is not readily visible, and the distinction between the anterior and posterior pillars is almost obliterated, causing it to present a nearly uniformly flat appearance. It has, moroever, a thin and flabby look generally. It is often said to be relaxed, and so it is; but it is more than this: you may tickle it with the handle of the mirror, and even prod it roughly, without exciting any sign of resentment in this usually irritable region. These are the phenomena attending *bilateral* defective innervation of the muscles of the palate.

In *unilateral paresis* of this region the distinctive features are much more marked. One side of the palatal arch is seen to have dropped, and there is the same tendency to obliteration of the arches of the palate on the affected side as obtains in the bilateral class. The uvula usually points to the sound side—frequently it is turned toward it in a remarkable degree. The record of my cases points to a greater preference of the paresis for the left rather than the right side, and it happens with about equal frequency in both sexes.

Respecting the influence of this state of things upon the hearing power of the patient, it will, I think, be clear, from the facts already insisted upon, of the intrinsic muscles of the ear being innervated from the same sources as supply the palato-tubal muscles, that the function of these (auditory muscles) will be in abeyance in like manner with the latter. It is probable that the salpingo-pharyngeus is not implicated in the paresis of the other muscles of the tube, as it has a quite distinct nerve-supply, and by its action on the upper and posterior portion of the tube may open it sufficiently to admit of air entering the drum cavity. This may be the reason why there is so little depression of the membrane in these cases, when viewed from the external meatus. At any rate, the patient is very deaf. The cause of the deafness becomes obvious when the faucial paresis is recognized, together with its auditory relationships. The hearing power of these patients is very variable; they usually hear fairly well in the morning, that is, after the recuperative effect of a night's rest; but the improvement wears off as the day lengthens.

As regards the nature of this paralysis, it is certainly not to be referred to a central origin. On the contrary, these cases belong essentially to loss of vaso-motor nerve-power affecting one or more ganglia of the sympathetic system. This general statement will not be understood to include those cases of palato-tubal paralysis seen in syphilitic patients, associated as it often is in them with paralysis of the corresponding vocal cord, and probably with other and wider-reaching indications of loss of nerve-power.

These *vaso-motor pareses* are very local in their manifestations, and depend entirely on the condition of the nervi vasorum of the nutrient arteries of the motor sensory nerves, and not at all on the condition of the sensori-motor centres. It is a question of nutrition of the muscular nerves themselves, and this depends on the blood-supply which again is regulated by the vaso-motor nerves. These patients are often anæmic and have undergone mental worry, besides physical wear and tear. Under such circumstances the nerve force is readily exhausted, especially that of the sympathetic system. Some particular ganglion parts with its force more readily than the rest. It is like an exhausted galvanic cell; you must recharge it before it will act. But while thus waiting for recharge, the coats of the vessels it should control become the play of physical forces, and under the influence of the heart's impulse they stretch and are distended with blood. This interferes with the nice balance between arterial tension and tissue demand which is essential to nutrition, and hence mal-nutrition results as far as the nerve-tissue is concerned, and hence there is defective motor function. Mechanical pressure exerted upon the motor fibrillæ is an important factor in the production of this paresis and is due to the great accession of blood within the nerve-sheath when the nutrient vessels, being deprived of their inhibitory control, experience an enormous dilatation of their calibre.

All this is restored by a proper course of therapeutics designed to recuperate the ganglionic inhibitory function.

The following case, which illustrates many of the points referred to in the foregoing sketch of the subject, will serve the further purpose of indicating the treatment most likely to prove serviceable in these cases:

Case.—Miss R., æt. 28, consulted me in the spring of the present year for great recent increase of deafness. She had been the subject of ear-trouble during infancy, but had recovered an ordinary amount of hearing power. It appeared that while skating in January she got into the water and was nearly drowned. She did not take cold from the misadventure, though the shock to her nervous system was very severe. Subsequently to this event she became gradually deaf. Some months previously her general health had been depreciated by having nursed her mother, to whom she was much attached, through a long and fatal illness. Physical fatigue added to mental sorrow had combined to exhaust her nerve-force, which culminated in the shock of the immersion with its nearly fatal consequences. The effect of this nerve-exhaustion was shown, and its bearing on the class of case under review was illustrated by the almost complete paresis of the soft palate which she presented at the time referred to. So great was the loss of power in this patient, that a strong faradic current applied to the palate excited no muscular action, and was scarcely felt by the patient. Associated with this condition was such a degree of deafness that the watch was heard only on contact, while ordinary conversation was quite inaudible. The membrana tympani of the left side was much depressed; there was coincident rhinitis limited to the anterior half of the nares, but the mucous membrane covering the inferior turbinated bones in this region was red and swollen, so that a catheter could not be introduced. The peculiar feature about the deafness was that it was much less marked on rising and in the early part of the day, when she could hear fairly; but this passed off, and she became quite deaf toward evening. The explanation of this circumstance I have already referred to the recuperative influence of a night's rest.

As regards *treatment*, the first step consisted in getting rid of the impediment to the introduction of the Eustachian catheter presented by the swollen and tender state of the mucous lining of the turbinated bones. For this purpose I directed her to sniff a solution of chlorate of potash, and in a few days introduced some *dilating bougies*, which I have had made for the purpose, and the use of which I take this opportunity of introducing to the notice of such of my confrères as are interested in the treatment of nasal affections. They are the ordinary gum-elastic urethral bougie, cut short. I use them in three sizes, and leave them in from fifteen to twenty minutes. I have often found it possible to pass such a straight bougie of a much larger size than the rejected catheter, and after a brief interval have been able to return to the latter with satisfactory results. The pressure they exert is painless, but most beneficial in causing the subsidence of those chronic thickenings of mucous tissue often met with in the inferior nasal meatus, and in very obstinate cases of this kind they may be retained for a much longer period. The flattened ring attached to the external end assists their manipulation, and prevents the possibility of their passing into the pharynx.

Having thus secured the re-ventilation of the tympanic cavity, an attempt was made to reinstate the indrawn membrane in its normal plane. For this purpose I used the pneumatic tractor, two applications of which, made at successive visits, sufficed to bring about a marked improvement in this respect. In the meantime treatment was directed to " build up " the patient's system generally, for which purpose steel, phosphorus, hydrobromic acid, and cod-liver oil were administered internally. I have made use of this term " build up the system " in deference to the vague phraseology generally adopted when therapeutic measures are in question. The medication indicated has, however, a much more intimate relationship to the theory of the causation of the symptoms which I have proposed than is implied in the foregoing expression. Phosphorus, steel, and hydrobromic acid possess a definite relationship to the vessel area innervated by the ganglia whose defective action produced the phenomena of paresis described in the former part of this paper. Their action is to increase the inhibitory power exercised by the ganglia over the vessels from which it had been withdrawn, and when this is restored, an involution process as regards the morbid effects of its absence at once commences, which speedily ends in the removal of the symptoms. This appears to be the rationale of the action of so-called " nervine tonics." The therapeutic effect of the salts of ammonia is essentially of this character, and was illustrated in the case of another patient in whom palatal paresis of the left side existed to a very marked extent, without deafness, but with loud tidal noises in the left ear, and to whom I gave gr. v. doses of sesquicarbonate of ammonia three times daily, with the result that all the symptoms disappeared in a fortnight.

In the case of Miss R., the induced current was applied locally with marked benefit and materially hastened recovery. In fact, it is always useful in these cases. In using it, one pole should be applied to the veil of the palate posteriorly, for which purpose the laryngeal electrode is very suitable; the other, an ordinary sponge-holder, is placed outside the neck over the superior cervical ganglion, which is reached by making deep pressure behind the angle of the jaw..

In conclusion, I wish once more to emphasize the importance of these cases of tubal deafness associated with paresis of muscle. The recognition of the complete correlation which exists between the muscles of the two regions imparts to the co-existent deafness a constitutional significance which at once tells its own tale. Mere loss of power in the muscles of the palate does not attract the patient's attention, for it is not sufficient to impede the act of deglutition, as whatever slight obstacle it may present mechanically to this act is readily overcome by the action of the tongue in carrying the food backward until it is brought within the grip of the constrictors. The accompanying deafness, however, at once attracts the attention, and often excites the alarm of the patient. The correct diagnosis of the causes operating to produce it is of paramount importance, because we are then warned of his constitutional condition, and may give a timely caution to restrain those mental or physical excesses which have already begun to undermine his nerve-force. At the same time the therapeutic measures to be adopted afford a most encouraging prospect of cure.

AUDIBILITY OF HIGH MUSICAL TONES.

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Since tests of hearing, by means of high musical tones, may be made to subserve an important purpose in determining the character and effects of changes, especially in the sound-transmitting apparatus of the middle ear, the consideration of the means by which the tones used for this purpose are to be produced becomes an important one—important both as concerns the accuracy with which the mechanical means employed produce certain tones required of them, since the rules for the construction of instruments for the production of tones above a certain pitch must be based entirely upon mathematical calculations; and as concerns the bearing which the quality of the tones produced may have upon their intra-aural transmission and perception.

Anything like an accurate determination of the correspondence between certain changes in the sound-transmitting apparatus of the human ear and the apparent perception of a certain range of high musical tones can be arrived at only as the result of careful and extended experiment, which shall secure for this method of hearing test the value for purposes of diagnosis, which it is capable of attaining. The object of this paper, therefore, is to consider briefly the comparative value of the two instruments most readily used for such tests, and to indicate in a general way the character of the changes in the sound-transmitting structures of the middle ear, which result in a deviation in the apparent perception of high musical tones from what has been generally ascertained as the normal standard, with the hope of inducing other observers to give to this subject the attention which it merits.

The two instruments most readily available for the purpose in question are the rods of König and the whistle of Galton. The former instrument consists of a series of steel rods, of uniform diameter, but varying length, suspended by a loop of cord or wire, and set in vibration by the stroke of a slender steel hammer. These rods, as originally made by König, are of Hobson's choice steel, white temper, two centimetres in diameter, and of length calculated to give tones corresponding to the untempered or musical scale. The rods used by the writer, in a series of initial experiments made in 1872, corresponded in all respects to those made by König, with this exception, that the rods were made in length to correspond to an arbitrary scale having intervals of 5,000 v. s. (single vibrations) in the second. The set included seventeen rods, the longest giving a tone of 20,000 v. s. and the highest a tone of 100,000 v. s.[1] The rods were suspended successively from a steel framework carrying a pendulum hammer swinging over a graduated scale, thus insuring a uniform force of stroke and corresponding intensity of tone.

For practical purposes in diagnosis, a set of nine rods, ranging from 20,000 v. s. to 60,000 v. s. only is necessary, and the rods may be set in vibration by the blow from the hammer held in the hand. In conducting the tests, the rods should be suspended at a uniform distance from the ear, in a direct line with the long axis of the external auditory canal. The point of suspension of the rods is a matter of importance, and is determined by calculation, two slots being cut in each rod, into which the loops of the suspending wire or cord are to be slipped.[2]

In testing cases of defective hearing, it is well to warn the patient to distinguish between the sound produced by the impact of the hammer and that resulting from the consequent vibration of the rod, and where there occurs a question as to whether the true tone of the rod was or was not heard, to repeat the experiment, the eyes of the patient being closed, first damping the rod by holding it between the fingers, and, second, setting it in full vibration. Furthermore, where continuous tinnitus aurium is a prominent symptom accompanying the aural disease, an interval of rest should be allowed between the tests with the several rods, as the tinnitus is frequently intensified by those tones which more nearly correspond to the apparent pitch of the subjective sound.

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[1] For more accurate tests, a series having shorter intervals is desirable.

[2] The length of the rod being divided by 4.3, the result gives the distance from the end of the rod at which the slot is to be cut: thus the length of a rod 2 ctm. in diameter, giving a tone of 35,000 v. s., is 70.5 mm.; 70.5 + 4.3 = 16.4: the points of suspension for this rod therefore should be 16.4 mm. from the ends of the rod.

Prof. H. P. Bowditch, Harvard Medical School, has devised a framework from which all of a set of rods may be simultaneously suspended and set in vibration successively by a hammer sliding over them—an arrangement of much convenience in rapidly conducted tests.

The whistle, one of several instruments devised by Mr. Galton, and which bears his name, as made by Messrs. S. C. Tisley & Co., London, consists of two tubes: the first, open at the bottom, and having a female screw within the base; the second, sliding over the first, and containing a plug accurately fitting the interior of the first tube, has at the base of the plug a male screw. The outside of the first tube is marked in a scale, the unit of which is $\frac{1}{25}$ of an inch. The rim of the outer tube is marked in ten divisions; the pitch of the screw used is 25 to the inch. One complete turn of the outer tube or cap, therefore, carries the plug upward or downward $\frac{1}{25}$ of an inch $= \frac{10}{250}$. The markings on the edge of the outer tube or cap correspond, therefore, each to one-tenth of a complete turn, or $\frac{1}{250}$ of an inch.

The scale of readings given in the pamphlet issued by Messrs. Tisley and Co. is as follows:

Scale Readings.	Single vibrations per Second.
10	84,000
15	56,000
20	42,000
25	33,600
30	28,000
35	24,000
40	21,000
45	18,666
50	16,800
55	15,273
60	14,000
65	12,923

Scale Readings.	Single vibrations per Second.
70	12,000
75	11,200
80	10,500
85	9,882
90	9,333
95	8,842
100	8,400
105	8,000
110	7,591
115	7,305
120	7,000
125	6,720
130	6,461

The whistle is blown by means of a small rubber ball fastened to the upper end of the first tube; and, as the plug is screwed upward, diminishing the depth of the whistle, the tone rises in pitch.

The scale, as above given, is calculated to mislead, and to favor false deductions from the apparent perception of tones in the upper limit of the scale. This fact is mentioned in the same pamphlet, where it is stated that the whistle is not reliable for tones above 14,000 v. s.; and the reasons for this unreliability, which are as follows, are given:

The vibrations of the air in a closed pipe being supposed to be strictly longitudinal, the number of vibrations in a whistle or closed pipe depends upon its depth, the length of each complete vibration being four times that of the depth of the closed pipe. This rule, however, ceases to apply when the depth of the tube is less than one and one-half times its diameter. In testing with this whistle, therefore, while the pitch of the tone rises with reliable regularity, with the rise of the plug in its chamber, to a point at which the end of the plug is distant from the upper end of its chamber one and one-half times the diameter of that chamber, beyond that point the pitch falls and becomes subject to certain laws of vibration which are still a matter of investigation.

As will be seen, therefore, the marking of the instrument above a certain point, to which only it is reliable, is liable to be a fruitful source of error, to those concerned only in its practical application, as a means of diagnosis.

Its convenience in handling, and the fact that it gives a sustained tone, are points of value; but, as the apparent limit of audibility of high tones rarely falls in the human subject as low as 14,000 v. s., it is comparatively useless to the diagnostician, except as a comparative test, as in distance-perception, when a sustained tone is particularly desirable.

The intensity of the tone of a König's rod diminishes regularly from the moment that it is set in vibration, while the intensity of the tone of the whistle evidently can be maintained; the auditory impression produced by the latter is therefore proportionately greater; and of two tones of the same pitch, sounded at the same distance, by a König's rod and a whistle, the latter will be more distinctly heard.

As will be seen from the above description, the König's rods must be relied upon for the more accurate tests, both by the physiologist and the diagnostician, the latter especially having for his object the investigation of changes in the sound-transmitting apparatus of the ear, the result of disease, which very rarely prevent the transmission of sound-waves of tones so low as the upper reliable limit of the whistle.

The initial experiments on the limits of audibility of high musical tones, already alluded to, as begun in 1872, were undertaken originally with the view of determining, if possible, the reason for the discrepancies in the statements of various authors, as to the upper limit of audibility,[1] and the experiments proved, as was expected: 1. That these discrepancies were in all probability due not to actual differences in the perceptive power of the subject tested, but rather to differences in the transmitting power of the structures of the middle ear. 2. That the real limit of audibility far exceeded the limit of transmission by the structures of the middle ear in a normal condition. 3. That changes in the sound-transmitting apparatus of the middle ear, in consequence of disease, for instance, produced corresponding changes in the limit of audibility, the apparent limit of perception, of high musical tones conveyed to the labyrinth through the external and middle ear, the inference being, therefore, that tests with high musical tones might be made to serve a useful purpose as a means of diagnosis when the correspondence between the apparent limit of perception and certain definite changes in the sound-transmitting apparatus of the ear had been sufficiently determined to afford a basis for the practical application of this test.

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[1] Summary of results of experiments on the perception of high musical tones. Clarence J. Blake: Trans. Am. Otological Soc., 1872.

The first step was of course to determine the limit of audibility of the normal ear, and for this purpose subjects possessing ears apparently normal to inspection and responding normally to other tests were chosen; it was found that the limit of audibility varied with the age,[1] younger persons possessing a higher limit of audibility; the average of a series of tests of over one hundred persons, from twelve to sixty years of age, gave the average upper limit as a tone of about 40,000 v. s.; the limit rarely sank below a tone of 35,000 v. s., and under voluntary retraction of the musculus tensor tympani increased from 3,000 v. s. to 5,000 v. s., and in one case 10,000 v. s. above the limit observable before the retraction of the muscle: the increased power of transmission under retraction of this muscle being explainable not merely by the fact of the increased tension of the membrana tympani and ligaments of the ossicula, but by the fact also that under these conditions the preponderance in weight of the malleus and incus above the axial line of their vibration is allowed fuller play as a counterbalance, and with the increased tension of the sound-transmitting apparatus —especially the membrana tympani and ligaments of the malleus and incus—increases its susceptibility in response to tones of short wave length.[2] It may be noted here that when the tension is increased beyond a certain degree, the functional activity of the sound-transmitting apparatus is at once interfered with and the hearing for high musical tones immediately diminishes.

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[1] Compare Francis Galton, F.R.S.: Limits of Audible Sound, Science Conferences, South Kensington Museum, 1876, p. 62. "I find that young people hear shriller sounds than older people, and I am told that there is a proverb in Dorsetshire that no agricultural laborer who is more than forty years old can hear a bat squeak." See also communication of Mr. Alexander J. Ellis, F.R.S., in the same report.

[2] Mechanical Value of the Distribution of Weight in the Ossicula. Clarence J. Blake: Trans. Am. Otological Soc., 1874.

The average limit of audibility having been determined as a tone of about 40,000 v. s., the structures of the middle ear may be said, in their normal condition, to present an obstacle to the passage of tones above this limit, and a decided variation in limit either above or below this average tone may be taken as evidence either of change in the sound-transmitting apparatus or in the true perceptive power of the ear. In the great majority of cases the variation in limit of audibility is due to changes in the middle ear, rarely rising above 80,000 v. s., and very rarely falling below 20,000 v. s. We have, then, what may be called an abnormal scale of audibility of high musical tones, the lower and upper limits of which may be assumed as tones of 20,000 v. s. and 80,000. v. s. Assuming the normal mean to be a tone of 40,000 v. s., any increase of the limit of audibility above this mean is usually the result, and may be taken, as a rule, as evidence of: 1. Increased tension of the sound-transmitting apparatus as a whole. 2. Elimination of one or more of the sound-transmitting structures which present an obstacle to the passage of tones above a certain pitch.

Any decrease of the limit of audibility below this mean may be taken, as a rule, as evidence of increased obstacle to the passage of sonorous vibrations, or, if the sound-transmitting structures of the middle ear are apparently, in response to other tests, in a normal condition, the inference is at least permissible either that the obstacle is still more deeply seated or that the perceptive power is itself at fault. Since the publication of the first paper on this subject it has received the attention of several observers, among them especially Prof. Moos,[1] Dr. Guerder,[2] and Dr. Laurence Turnbull,[3] and the writer has been encouraged to continue a series of experiments and clinical observations, still in progress, looking toward a more accurate determination of the value of such tests.

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[1] S. Moos: On Defective Perception of certain Consonants, combined with a similar Defect as regards High Musical Notes; with the Physiological Significance of the Same, Archives of Ophthalmology and Otology, IV., 3–4, p. 469.

[2] Guerder: L'otologie dans les dix dernières années. Méthode de Blake. Annales des maladies de l'oreille et du larynx, Paris, No. 6, Dec., 1877, p. 362.

[3] Proceedings Am. Assoc. Adv. of Science, 1874. Boston Med. and Surg. Journal, May 29, 1879. Dr. Turnbull makes the interesting observation that in persons of trained hearing, musicians and others, the limit of hearing is above the general average recorded by other observers.

The first series of experiments relate to the rise of the limit of audibility above the assumed normal mean; the second to the fall of the limit of audibility below this mean.

I. The measurements of the excursions of the membrana tympani and ossicula under vibration, made by Burnett, Buck, Weber-Liel, and others, the diminution in weight of the ossicula and the progressive increase in delicacy of the sound-transmitting structures of the middle ear passing inward would lead us to expect a corresponding increase in the susceptibility of the structures individually in vibration to high musical tones. That this is the case is shown, among others, by the following experiments and observations: In a case of small calcareous deposits in the posterior portion of the right membrana tympani, the limit of hearing for high musical tones being 35,000 v. s., and the patient consenting to an experimental operation, an incision was made in the membrana tympani opposite the descending process of the incus, and a flap formed, which was turned inward and stuck by means of paper sizing to the process of the incus. The hearing for high tones increased to 50,000 v. s. (the incision was then continued downward, and a Politzer eyelet inserted, when the hearing rose to 80,000 v. s.).

Shortly after this experiment, a patient, a young man, twenty-eight years of age, presented himself, complaining of diminished hearing for voices in conversation and an apparently corresponding increase of hearing for shrill tones. This had been the case since an accident in hunting, a year previously, when the unexpected discharge of his gun had been followed by severe pain, sensation of shock, and tinnitus aurium in both ears. The latter symptom continued several days, gradually diminishing, and he then experienced the difficulty in understanding mixed conversation alluded to, and found, also, on his hunting expeditions, that he could apparently hear bird notes which were inaudible to his companions. The case was a fortunate one, at least for the observer, as on examination it was found that there had been a rupture in the posterior portions of both membranæ tympani, the resultant cicatrices being in the one case attached to, and in the other in contact with, the descending process of the incus. The hearing, as tested by König's rods, showed a limit of audibility in both ears for a tone of 60,000 v. s., the perception being more marked in the ear in which the adhesion had taken place.

This case, confirming the less valuable experimental case which had preceded it, led later to the application of small discs of thin paper in cases of perforation of the posterior superior segument of the membrana tympani, the paper disc being so applied as to rest in part upon the membrana tympani and in part upon the descending process of the incus. The adhesion of the discs was insured by using sized paper, moistened. In these cases, also, the direct transmission of the vibrations from the receiving-surface to the incus, eliminating, as it were, the malleus and malleo-incudal articulation, resulted in an apparent increase in the perception for high tones, the upper limit ranging from 45,000 v. s. to 55,000 v. s.

The average limit of high tones transmissible by the middle ear apparatus, as a whole, in its normal condition, therefore, being taken as 40,000 v. s., and the elimination of the malleus and its articulation increasing the limit of transmission to 60,000 v. s., the difference, 20,000 v. s., may be taken as representing the inertia of the mass of the malleus together with the loss of power in transmission through the malleo-incudal articulation.

The next step in experiment was to allow the sound-waves to enter the middle ear without intervention of either membrana tympani, malleus, or incus, the sound-waves setting the stapes directly in vibration. This was easily accomplished by selecting cases of perforation of the membrana tympani in which the acute process causing the perforation had subsided, leaving the tympanic mucous membrane in a comparatively normal condition; and also by perforating the membrana tympani, for this purpose taking advantage of cases in which the experimental insertion of the Politzer eyelet was proposed. These latter cases could, of course, give only comparative results, as the condition which made the attempt to use the eyelet justifiable, implied changes in the tympanic mucous membrane which would interfere with the transmission of sound-waves and with the proper vibration of the stapes. The former cases needed also to be carefully selected, as it could, of course, occur but rarely that an inflammatory process sufficiently severe or sufficiently protracted to result in large perforation of the membrana tympani should not have left more or less extensive and permanent traces upon the tympanic mucous membrane and in the structures of and surrounding the stapedal articulation.

In two cases of experimental perforation of the membrana tympani the limit of hearing for high musical tones reached 80,000 v. s. In one other similar case the patient positively asserted the hearing of a rod giving a tone of 100,000 v. s. The tests in this latter case were many times repeated, the patient being blindfolded and the rod struck at a distance of one inch from the ear, both damped and free, with the result asserted; but, as this observation has not been confirmed by subsequent experiment in any similar case, it should be considered as of doubtful value.[1]

In three out of six cases (selected from the first series tested) of large perforation of the membrana tympani, the tympanic mucous membrane being clear and transparent, all the ossicula being in position, a tone of 80,000 v. s. was distinctly heard. In these cases there had been no discharge from the middle ear for periods varying from three months to one year. In the remaining three cases there was more or less congestion of the tympanic mucous membrane, and in one case slight muco-purulent discharge. In this latter case the limit of hearing was only 45,000 v. s., and in the other two cases 55,000 v. s. and 60,000 v. s. In order to test the influence of the congestion of the tympanic mucous membrane upon sound-transmission, one of the first three of the six cases was selected, and the vapor of chloric ether injected, by means of the Politzer air-douche, the orifice of the ear being stopped; brilliant reddening of the mucous membrane resulted, and the limit of hearing dropped to a tone of 65,000 v. s. To further test this effect, a case of old purulent inflammation of the right middle ear, in which the incus had previously come away, and where there was almost destruction of the membrana tympani, was selected, and continued under observation. This case had previously been under treatment, and, when it first came under observation, the only remaining symptoms of active disease were a considerable congestion of the tympanic mucous membrane and a group of small granulations in the region of the stapes, the head of which projected freely above the swollen tissues around it. The hearing for high musical tones ranged from 35,000 v. s. to 40,000 v. s.

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[1] See Archives of Ophthalmology and Otology, Vol. IV. Nos. 3–4. Prof. Moos repeated this experiment without obtaining confirmatory results, in consequence, probably, of deeper-seated obstacles to the passage of the sound-waves, the existence of which was left out of consideration. The cases cited in the paper (Boston Med. and Surg. Journal, 1872), to which Prof. Moos alludes, and repeated in the present paper, were selected from a large number of cases as illustrating the highest limit of hearing for musical tones observed. The hearing in the great majority of these cases fell far below this limit, in consequence of changes in the deeper-seated parts of the sound-transmitting apparatus, the result of disease.

Under treatment directed to the removal of the granulations, the hearing for high tones gradually improved until, with the cessation of all discharge, and the clearing up of the mucous membrane, it ranged from 65,000 v. s. to 70,000 v. s. In all the cases of this latter class (large perforation of the membrana tympani) tested, sixty in number, the limit, with exception of the questionable case mentioned, did not rise above 80,000 v. s., and frequently fell below this figure.

Taking 80,000 v. s. as the extreme limit, the difference between this tone and one of 60,000 v. s. may therefore be said to represent the inertia of the mass of the incus, together with the loss of power in transmission through the incudo-stapedal articulation. There must also be taken into account the effect of the unbalanced retraction of the musculus stapedii upon the unsupported stapes, on the one hand, and the effect of the combined inertia of the ossicula, and of pathological changes in the tissues of the stapedal articulation, on the other, as presenting obstacles to the transmission of sonorous vibrations.

Were the stapes allowed to vibrate unhindered, I am inclined to believe that the limit of its transmission of high musical tones would exceed that of a tone of 80,000 v. s.

II. The conditions which present a greater obstacle to the transmission of short sound-waves than that presented by the normal sound-transmitting structures of the middle ear, constituting a part of their function of protection to the deeper-seated organ, are of various kinds, and may be briefly summarized as follows: mechanical obstruction, increased inertia, and diminished tension. The dividing-lines between these cannot be distinctly drawn, one condition often implying one or both of the others. They are chosen merely for the purpose of formulation.

Any mechanical obstruction, a foreign body in the external auditory canal, or fluid in the tympanic cavity, for instance, presenting an obstacle to the passage of sound-waves, will, of course, interfere with the perception of high musical tones; in the latter case the amount of the accumulation, its position, and the consistency of the fluid, all other things being equal, produce a marked effect, as has been repeatedly observed in cases of serous accumulation, the hearing for high musical tones increasing with the diminution of the fluid accumulation, especially as the posterior and inferior segments of the membrana tympani were left free to vibrate. As a rule, also, in these cases, the hearing for high tones was found to be better when the fluid was a thin, limpid serum than when it was thick and tenacious; and in several cases it was observed that a drop of thick, tenacious fluid lodged between the long process of the malleus and the opposite tympanic wall interfered more with the transmission of vibration, through the medium of the membrana tympani and ossicula, than a larger quantity of thinner fluid elsewhere.

The possible effects of these and similar extrinsic obstacles to the passage of sound-waves within the ear is sufficiently evident upon very superficial consideration.

The study of the effects produced by intrinsic obstacles, however—that is, by changes occurring within the structures of the sound-transmitting apparatus itself, or rather the determination of the character of the changes, as corresponding to the diminished hearing of high musical tones, and their localization—is by no means an easy matter. And the proper estimation of the effects of these changes upon the apparent perception of high musical tones which shall positively fix their value as a means of diagnosis, can be arrived at only as the result of careful comparative experiment by several independent observers.

As examples of changes in the membrana tympani and ossicular chain, as the result of disease, which increase the inertia of this apparatus, either in whole or in part, and therefore the transmission of high musical tones, may be cited: the thickening of the outer coat of the membrana tympani, which accompanies or follows inflammatory processes in the lining of the external auditory canal; maceration and partial separation of this outer coat; hemorrhagic effusion, and the consequent coagula which follow an acute inflammation of the middle ear; calcareous deposits, which, by their weighting of the membrana tympani, interfere with its proper vibration; and, as results of acute or chronic inflammation of the middle ear, the membrana tympani remaining unperforated; thickening of the tympanic mucous membrane; changes occurring in the articulations of the ossicula, in consequence of acute inflammation; and the formation of adhesions and synechiæ. In all of such cases the diminution of the hearing for high musical tones below the assumed normal standard may be taken as a measure of the increased resistance offered to the passage of sound-waves, considering always that the tones employed are produced of uniform intensity, an increase in intensity serving to overcome the inertia of the parts in proportion to the increase in the amplitude of the sound-waves.

As broad examples of what may be called diminished tension, in place of a better term, may be cited the effects produced by relaxed cicatrices of the membrana tympani, which exercise a notable effect upon the transmission of high tones to the deeper-seated parts of the sound-transmitting apparatus, as well as a decided influence in diminishing the general hearing, it being well known that, all other things being equal, the more nearly the tension of a cicatrix approaches that of the normal membrana tympani, the more readily will the membrane, as a whole, respond in vibration to the sound-waves impinging upon it. Another example may be found in the relaxation of the capsular ligament of the malleo-incudal articulation, which sometimes occurs as the result of unlimited inflation of the middle ear. The diminished tension of this ligament being accompanied by and permitting a diminished tension of the membrana tympani, the membrana tympani and malleus not only offer more than the normal obstacle to the passage of sound-waves, but, in consequence of the relaxation of the capsular ligament, the slight excursions resulting from the sound-waves of the higher tones, not being transmitted to the incus, are lost, as it were, in the articulation.

From this brief review of the subject, which in detail deserves, and at some time in the future will receive, more elaborate consideration, it would appear:

1. That the upper limit of audibility of high musical tones by the normal ear being taken as the standard, any considerable deviation from this standard, within certain limits, may be taken as evidence of an abnormal condition—*a*, of the sound-transmitting apparatus of the middle ear; *b*, of the sound-transmitting structures of the labyrinth; *c*, of the auditory nerve and the ultimate organ of perception.

2. That any *increase* in the apparent perception of high musical tones may be taken as evidence of—*a*, increased tension of the sound-transmitting apparatus, in whole or in part, up to a certain limit, beyond which the hearing for these tones diminishes; *b*, increased facility for the transmission of short sound-waves to the labyrinth by the elimination of parts of the sound-transmitting apparatus of the middle ear, which, in their normal condition and connection, offer more or less of an obstacle to the passage of tones above a certain pitch. If, under these conditions, which experience shows favor an apparent perception of high tones above the normal standard, this increase in hearing is wanting, it may be taken as evidence either of the existence of a counterbalancing obstruction or of a real diminution of the perceptive power.

3. Any *diminution* in the apparent perception of high musical tones may be taken as evidence of—*a*, an increase of the obstacle presented by the sound-transmitting apparatus of the middle ear, in consequence of changes in that apparatus; *b*, annihilation of the physiological function of the fenestra rotunda and ossicula, in consequence of increase of intra-labyrinthine pressure;[1] *c*, an ob-

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[1] **In his investigations, published in the Archives of Ophthalmology and Otology, Vol. II., No. 2, C. H. Burnett shows "that an increase of labyrinth-pressure beyond a certain point annihilates the physiological function of the fenestra rotunda**

stacle presented to the passage of sound-waves by changes in the sound-transmitting structures of the labyrinth; *d*, real diminution of the perceptive power.

Since the transmission of the short sound-waves of the higher musical tones demand the greatest delicacy in the performance of the function of sound-transmission by the structures of the middle and internal ear, any disturbance of this function—the perceptive power being normal—will be likely to show itself in variation in the upper limit of audibility. The use of high musical tones becomes of value, therefore, not as an independent, but as a comparative, test; and it should be borne in mind that the accuracy of the observation should be proportionate to the delicacy of the test. The test being frequently repeated in any one subject, under, as nearly as possible, the same external conditions, care being taken to avoid anything which may influence either the imagination or judgment of the subject tested, since, in using the König's rods, as the upper limit of audibility is approached, it becomes more and more difficult for the listener to distinguish between the sound made by the impact of the hammer and the "ring" which marks the true tone of the rod.

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and ossicula, and, further, that the suspension of these physiological functions occurs sooner for high than for low notes." See, also, Moos, Vol. IV., Nos. 3-4.

EXPERIMENTAL RESEARCHES IN THE DETERMINATION OF THE FORMS OF ACOUSTIC WAVE-SURFACES, LEADING TO THE INVENTION OF THE TOPOPHONE, AN INSTRUMENT TO DETERMINE THE DIRECTION OF A SOURCE OF SOUND.

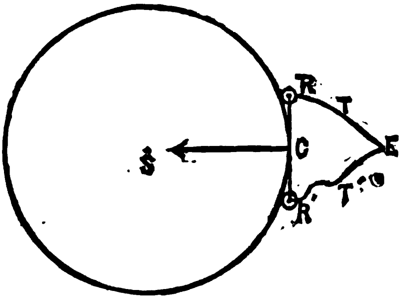
BY ALFRED M. MAYER.

IN the November number of the *American Journal of Science* for the year 1872, I published a paper entitled, " *On a method of detecting the phases of vibration in the air surrounding a sounding body; and thereby measuring directly, in the vibrating air, the length of its waves and exploring the form of its wave surface.*" So far as I have been able to ascertain from the records of science, I therein described a process which first enabled one to explore the acoustic condition of the atmosphere. By means of resonators connected by tubing with König's manometric flames, or with the ear, I actually measured in the free air the length of sonorous waves; and succeeded in gliding the mouth of a resonator over the sonorous wave-surface, and thus traced out, in space, its form. Subsequently, in the *American Journal of Science* of December, 1872, and February, 1873, I published accounts of further applications of this new method of research in the invention of an acoustic pyrometer and in the experimental determination of the relative intensities of sounds. Finally, I read before the National Academy of Sciences, at the meeting in Washington on April 18, 1876, a paper " *On methods of exploring the acoustic condition of the atmosphere, leading to the experimental determination of the direction of a source of sound.*" I have thus been particular in giving the dates of these papers, for since their publication others have made extensive use of my methods without the slightest mention of my name as connected with them.

The paper of April, 1876, was read before the Academy to call attention to the important application of my method to the determination of the direction of a fog-horn signal off a coast during a fog. This application of my methods had been made several months before the April meeting of the Academy, and I had experimented enough to see that the theoretic conditions necessary for the attainment of this much-desired end could be readily conformed to in an instrument then described and subsequently called by me the *Topophone*, a word compounded of *topos*, *place* or *quarter*, and *phonos*, *sound.*

In this paper I will present a short general account of the method employed, and then give some recent results of actual work with the apparatus off the coast this summer, in connection with my esteemed friend, President Henry Morton, the Chairman of the Committee on Experiments of the U. S. Light-house Board.

In my paper of 1872, I was bold enough to state that "when the method I have here blocked out shall have been reduced to the refinement which it is susceptible of, I feel confident that we will have in our hands the power to attack many problems of high theoretic interest which have heretofore been deemed beyond the reach of experiment. Its applications to such are so numerous that they are almost co-extensive with the phenomena of sound." Before the Washington meeting of the Academy in April, 1876, I showed how the deformation of wave-surfaces, caused by differences in velocity in different directions from the sonorous centre, could be determined, and how the effects of inflexion and reflection could be detected. The recent work with my apparatus shows that the opinions then expressed were well founded.



Let S, of the diagram, be the source of a sound, and let the circle represent a wave-surface produced by that sound. On this surface all the molecules of air have, at the same instant, the same direction and the same velocity of vibratory motion. If we can accurately determine two points, R and R′, on this wave surface, and this wave surface be a spherical one, that is, is not deformed, then a perpendicular, C S, erected to the centre of a chord drawn between these two points will, when produced, pass through the source S. Our method consists in determining these two points on a sonorous wave-surface, as follows:

Let R and R′ be two resonators accurately tuned to the note given by the vibrating body at S. Suppose both resonators at the same instant on the wave-surface, then they both receive, at the same instant, the same phase of vibration on the planes of their mouths. If two tubes of *equal* length lead from the resonators and join into one tube just before they reach the ear E, then the sound-pulses will act together, being of the same phase, and the ear will receive double the action which it would if only one resonator were connected with the ear. But suppose that one of these tubes T′ differs in length from the other tube T by one-half of a wave-length of the tone given out by S, then the same pulses will no longer work together at E, but will be opposed to each other in their action, neutralizing each other's dynamic effect, and producing silence at the ear E. This last condition is the one used in our method. This arrangement we have used since December, 1872, to trace out a wave-surface surrounding a sounding body. This is done as follows: Keep one of the resonators, say R, at a fixed point, while the other resonator, R′, is moved around S, keeping it always at such distance from S that silence (or a minimum sonorous effect) is perceived. These various positions of R′, when silence is perceived, are points on the acoustic wave-surface.

To adapt the method to the determination of the direction of the source of sound S, we connect the two resonators, R and R′, by a rigid rod, and it is evident, if a pointer be placed at the centre of this rod and at right angles to its length, that when the resonators R and R′ are on the wave-surface, the rod C S will point toward the source of sound at S. The rigid rod connecting the resonators R and R′ turns on a vertical rod passing through C. This was the arrangement described before the National Academy in April, 1876. Of this particular application of the apparatus I will speak further on.

Let us imagine three different axes around which C, the centre joining the resonators R and R′, may revolve. This will give us three cases to consider and will show the fertility of this method of exploring the acoustic wave-surface:

First Case.—The axis of rotation passes *vertically* through C. This is the case we have just considered, and is the position in which the Topophone is ordinarily used. When the resonators R and R′ revolve around this axis, and they are distant from each other by *less* than a wave-length, then silence will only be obtained in two positions, viz.: When the mouths of the resonators are on the wave-surface, and as their mouths may either face the source S or be turned away from it, we will have two positions of the pointer, 180° distant from each other, when silence is perceived. There are methods, however, of ascertaining whether the pointer is toward or directly away from the direction of S. This will be embodied in the apparatus, and will be explained in another communication.

The experiments just described serve to fix points of the wave-surface in a horizontal plane. If there is any deformation of wave-surface in this plane it will be shown by the pointer taking a direction which is away from S when silence is perceived.

Second Case.—Let the axis passing through C be in a horizontal position, and so placed that the plane in which the resonators rotate passes through the source S. In this case we will have the same effects as in case first; that is, silence is perceived both when the pointer is directed toward and away from the source S. In this case we determine two points of a wave-surface situate in a vertical plane. Should the wave-surface be that produced in a homogeneous and quiet atmosphere, these two points will be in a vertical line; but if the atmosphere is unhomogeneous or disturbed by the difference of the velocity of the upper and surface wind, as Stokes, Henry, and Reynolds infer, then the two resonators will not be in a vertical line when silence is produced, but will be inclined away from the perpendicular to the horizon.

Third Case.—Let the axis of rotation of the resonators be horizontal and pass through C and S. In this case, if the wave-surface be spherical, we will have no break in the silence, for the mouths of the resonators will describe a circle whose circumference will always be in the wave-surface; but if the wave-surface be deformed by wind or unequal temperature of the medium, etc., then silence will not be maintained on rotation around C S, as the resonators will not always, at the same instant, receive the same phase of vibration, since both cannot possibly always be on the wave-surface at the same time. This case third gives a very simple and neat way of determining whether a wave-surface is deformed.

Short account of some recent experiments with the Topophone. —At distances from one hundred feet to one thousand feet I found that the direction of the source of sound could be determined to about one and one-half degree. These experiments were made in connection with Mr. S. A. Reed, of New York, in the upper part of the New York Central Park.

Experiments off the Sandy Hook siren fog-horns, at distances of four and five miles, and off Eaton's Neck fog-horns, at distances from four to six miles, showed that the direction of the source of sound could be determined to about 10°, or less than a point, even when the apparatus was used by inexperienced hands.

In conclusion I will make mention of an interesting fact in connection with the use of the Topophone on fog-horns. The sounds of these horns are necessarily composite, so when the position of silence for the fundamental tone is reached, the sound appears suddenly to jump up an octave. It then would seem that this apparatus may one day serve in certain cases of the analysis for sound.

I have not given the details of the construction of the Topophone. These will be given when I publish the specification of the patent of this instrument.

IODOFORM AND ALUM IN AURAL THERAPEUTICS.

BY H. N. SPENCER, A.M., M.D.,

SAINT LOUIS.

THE peculiar location of the lesion, with the peculiar structure of the tissues involved, constitutes the chronic suppurative inflammation of the middle ear, a disorder of exceeding interest to the surgeon.

When it has been analyzed, there is presented a variety in its forms which obtains for no single disease in any other organ of the body. It may be said to constitute a class of diseases—including its complications and consequences. It gives the aural surgeon more concern, at the same time that it affords him more brilliant results, than issue probably from any other derangement to which the ear is liable. It cannot ever be uninteresting to study its peculiarities in the light of clinical teaching. I propose very briefly to give my experience with the use of iodoform and alum in the treatment of this affection.

Iodoform in composition is an analogue of chloroform ($CH\ Cl_3$), the three atoms of chlorine being replaced by three atoms of iodine. It probably has its greatest reputation as a topical remedy in association with venereal sores. It has been held as a valuable therapeutic agent in certain chronic diseases of the eye and eyelids, in corneal ulcerations, phlyctenular and pustular ophthalmia, obstinate keratitis and trachoma. It is a powerful and rapid promoter of absorption. Dr. Moleschott,[1] of Turin, says that, before promoting absorption, it determines the destruction of the primitive elements. This reference to the action of iodoform suggests the condition of the lining membrane of the tympanum, in which its use would be expected to accomplish the most good. My experience with it has entirely confirmed these theoretical indications, and I am prepared to say that we may limit the use of iodoform to the hyperplastic processes which occur in this disease, and to secondary ulcerations. It has been in dealing with the former that I have secured the most gratifying results from its employment, and I shall only refer to these cases. It must not be regarded, however, as indicative of any want of faith on my part in results which have been claimed by others, or in results which I may hope to obtain myself in the latter, that I am unable as yet to say much for it in this direction. In order better to illustrate the value and action of this agent, I present the following cases:

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[1] **Medical Record, Nov., 1878, London.**

CASE I.—Mrs. H. H. A., ætat. 24, a young married woman, has been subject to a constant discharge from both ears since an attack of scarlet fever at twelve years of age. I found, on examining the left ear, a papillary growth, extending one-half the length of the meatus, resting on the floor of the meatus, and having a broad attachment to the inner wall of the cavity, to the lower and posterior slope of the promontory, extending to the floor of the tympanum. The membrana tympani had been entirely swept away. Absorption of the long process of the hammer had occurred, and the head of the bone seemed embedded in a growth of connective tissue. She was exceedingly nervous, in a great measure due to the poor state of her health, and I could by no persuasion, or in efforts to escape her observation, succeed in introducing an instrument for the removal of the polypus. I consequently had to content myself with cleansing by means of the bath and absorbent cotton. I then applied, by the cotton-holder, finely powdered iodoform, confining its application to the diseased tissues, and extending it to the base of the growth. Under the influence of a few applications the growth entirely disappeared. After the removal of this source of irritation, the tissues quite rapidly took on a healthy action, and the ear made a good recovery.

I need not refer to the condition of the right ear, which required a different treatment.

CASE II.—G. R., ætat. 6, was placed under my care October 3, 1877. The left ear had discharged constantly for four years, following scarlet fever. The membrana tympani was absent, and the manubrium of the malleus, preserved entire, rested upon the promontory without adhesions. There was slight swelling and proliferation of the whole mucous membrane of the tympanum. From the roof of the cavity, on each side of the head of the hammer, there were villous projections. I removed these repeatedly in the course of twelve months, so far as they were in view, and made the customary applications to their bases, but they persistently recurred. I tucked pellets of cotton moistened with a saturated solution of nitrate of silver into the recess, with only temporary effect. After a tedious experience, lasting for more than a year, during which time the patient had been constantly under care, and every agent familiar to me had been tried and had failed, I applied iodoform. Bending the point of the cotton-holder, I carried the application well up. The result was well nigh magical. The discharge, which had been always present, and at times copious, speedily ceased. After three weeks of treatment, from the time of the first application of iodoform, I was able to discharge the case.

CASE III.—S. A. H., ætat. 10, was brought to me December 7, 1878, presenting a chronic suppurative inflammation of the middle ear (right), which had existed for seven years. A mass of polypoid granulations occupied the posterior superior quadrant of the labyrinth wall of the tympanum, and there was a similar mass on this wall near the floor (central). The drum-head was gone, as in the two previous cases. To remove these proliferous masses, I at first employed escharotics—using in turn chromic acid, nitric acid, and nitrate of silver—with no beneficial results. The application of iodoform caused them to disappear, and the cavity soon entirely healed over.

I have not given these cases in detail, as it would occupy space unnecessarily. In reciting them, my object has been simply to illustrate the conditions indicating the use and the prompt action of this drug. I might present additional cases, but think that these will suffice.

The value of iodoform in aural surgery is still further enhanced by the good results which are obtained from its employment in naso-pharyngeal practice. I have had results from its use in the treatment of hypertrophied tonsils, which warrant me in strongly recommending it in this frequent complication of aural disease. It may not be amiss to refer to my methods of application in these cases. The crystals of the drug are forced into the lacunæ. Where the lacunæ are narrow, I have first introduced, on the point of the cotton-holder, crystals of chromic acid, and, when the slough has been discharged, have employed the iodoform. I am not aware that it has been used for this purpose in the manner here described by any other than myself. Iodoform degenerates with age and exposure, which should be borne in mind by the operator.

Alum.—I have associated this remedy with iodoform in this paper in order to bring out the more strongly the marked peculiarities of each as they stand related to pathological conditions in the middle ear. The diseased condition of the tympanum, according to my observation, which would suggest the employment of alum, is just the opposite of that in which iodoform would be indicated. There is this similarity between them: that they are each contraindicated in active processes of inflammation. The peculiar stage of a suppurative process in which alum is serviceable will be better understood from the statement that its good effect is due more to the mechanical protection which it affords, by its action upon the tissues, than to any medicinal influence which it exercises, either locally or constitutionally. It is when the sore has been deprived of its vicious elements through the agency of other remedies that alum often comes in and completes the cure. Schwartze has recommended it after nitrate of silver.

According to my belief, the alum must form a coagulum with the albumen of the *tissues*, and thus make an *adherent* coating. This gives the surface complete protection from atmospheric influences. It is this pernicious influence which often renders it so difficult to perfect the healing process in the class of diseases we are considering. At an earlier period than this which I have intimated, applications of powdered alum have not seemed to me to do good. The coagulum which it forms with the mucus or pus becomes a considerable mass, and, as a foreign body, a source of additional irritation.

We can confidently rely upon the action of these agents where the indications for their use have been carefully made out, and they deserve an exalted place in the list of remedies which constitute our aural armamentaria.

It may be well to remark that their application by insufflation is not to be recommended. Like the instillation of nitrate of silver, the agent is brought in this way into contact with the healthy structures of the middle ear and meatus, and might be attended with evil consequences, while it is always slovenly surgery.

BOOK NOTICES.

DISEASES OF THE EAR. By GEORGE P. FIELD, M.R.C.S. Second Edition. Pp. 236. London: Henry Renshaw. 1879.

THE demand for a second edition of a work in less than three years, which was the case with Mr. Field's book, shows that the subject of which it treats has not been devoid of interest to the profession. In the preparation of this edition of his book the author has increased its size by about one hundred pages, a portion of this new matter consisting of chapters on the anatomy of the ear and the physiology of hearing.

The third chapter is on the examination of the ear. The American reader will doubtless be somewhat surprised to learn that Mr. Field prefers, for the ordinary examination of the ear, the Brunton Otoscope, for we usually regard the English as eminently practical and not disposed to lay aside the more simple yet effective specula for the unwieldy apparatus to which reference is here made.

A watch, held to the ear, is recommended as the best means of estimating the ordinary defects of hearing, a test we hope before long to see the aurist omit for that of the voice. We should state, however, that the author has not omitted the mention of other means, as the tuning-fork and voice.

The usual practice of aurists, in presenting diseases of the auricle in a chapter by themselves, has not been adopted by the author, and what he has to say on this subject is to be found in the chapter on Diseases of the External Meatus. We have not space to notice the author's account of the affections thus grouped, in detail, but his directions for syringing the ear are worthy of attention, for it is an operation found by experienced aurists to require patience as well as skill to accomplish the object and avoid injury to the ear. Nothing appears more simple to the tyro, when provided with a syringe and warm water, than the dislodgement of a foreign body in the meatus; but the experienced surgeon will never become so expert that he can afford to perform this apparently simple operation without patience. In the removal of foreign bodies from the meatus of children, Mr. Field recommends that the patient be placed under chloroform and the ear affected turned downward while the syringing proceeds.

A perusal of Chapter VI., in which the author treats of acute catarrhal affections of the middle ear, plainly shows that the tendency of the aurists of to-day is toward a more gentle treatment of these affections, an example of which is Mr. Field's recommendation to frequently pour warm water into the ear, to avoid the violence of syringing which may with more propriety be resorted to in later stages where retained purulent secretions require more force for their removal. The author, however, seems to vary somewhat from this in his rather pronounced tendency to open the tympanic cavity in most instances, and quotes Roosa as recommending "that a cataract needle should be passed through the posterior membrane, in any case, whether bulging is seen or not, when the use of leeches does not markedly diminish the pain within a few hours." We believe (S. S.) that the operation of paracentesis in acute cases is now justly falling into disuse.

Referring to the use of the nasal douche, in Chapter VIII., as a means for dislodging the products of catarrhal inflammation from the pharynx, the author says that, although effective, its use is attended with risk, and it is not, therefore, recommended.

In the treatment of chronic suppurative inflammation of the middle ear astringent lotions are recommended, a favorite one consisting of sulphate of zinc and carbolic acid, five grains each to ℥j. of water, which when warmed is to be poured into the ear from four to five times a day. We should regard a general use of the foregoing as likely to prove irritating in many cases, its strength being greater than we have found desirable when using medicaments in this manner. The use of lotions is now altogether avoided by some aurists, it being considered unadvisable to keep the parts in a condition of humidity, which favors the development of granulation tissue in the tympanum.

The results of suppurative inflammation are the subject of two chapters, which are very complete and contain an interesting collection of cases illustrative of disease of the mastoid cells, of aural polypi, facial paralysis, abscess of the brain, pyemia, abscess of the lung and liver, epilepsy, etc. Mr. Field shows a commendable devotion to his subject in the labor he has bestowed in the collection of these cases, and they are a valuable contribution for reference.

Not so much praise, however, is due the author for setting aside a large amount of space for cases devoid of interest to the reader; there are one hundred and four of these.

Diseases of the internal ear are the subject of Chapter XIII., a subject of which it may be said that as yet our pathology has taught us but little when compared with the advances made regarding the middle ear. The author, however, really contributes something toward clearing up the ground here by implying that diseases heretofore classed with nervous deafness may most likely depend on anomalies of another region, an instance being the deafness of typhoid fever, concerning which he says, "I agree with Burnett in thinking that in the vast majority of cases of deafness due to typhoid fever, the affection of the labyrinth is secondary to a tympanic disorder."

The subject of *tinnitus aurium* next claims the author's attention, but nothing new is advanced in this intricate subject of physiological acoustics.

The author claims that faradization in his own hands has been of great benefit in the treatment of *tinnitus aurium,* although the results have not been always lasting. Our own experience seven years ago did not encourage a continuance of this treatment in tinnitus, although, where the symptom did not depend on anomalies of the conductive apparatus, there was reason to hope for beneficial effects. Mr. Field relates a case of alarming *tinnitus aurium* which was supposed to depend on a near approach to cerebral hemorrhage. The arterial tension was treated by the abstraction of twenty ounces of blood, a procedure that was followed by immediate relief.

Mr. Field concludes with a chapter on the general pathology of aural diseases, which will be of interest to those who have not access to Green's excellent translation of Schwartze's Pathological Anatomy of the Ear. In the preparation of this second edition of his work the author has made a better arrangement of the subject-matter, and there is an improvement in the style. He has availed himself of the current otological literature to bring together a considerable mass of clinical experience, thus making his book of value for reference. The book is illustrated, particularly by colored plates of the membrana tympani, which are intended to be looked at through an aural speculum. The effect gives a more accurate conception of the picture.

De l'Écoulement de Sang par l'Oreille, d'origine traumatique. Thèse pour le Doctorat en Médecine, par Gauthier (G.M.A.). Paris, April 12, 1879.

This thesis shows conclusively that hemorrhage from the ear after severe injuries is not necessarily a symptom of fracture of the petrous bone, and therefore not a symptom of fatal import. The thesis is divided into two parts, viz.:

1. Surgical traumatic otorrhagia. 2. Accidental traumatic otorrhagia. The first occupies but a small part, as the interest of the writer centres in the second variety of aural hemorrhage.

In the first chapter of the second part, traumatic lesions of the auditory canal are considered. These are due to laceration of the skin of the canal, to a rare form of loosening of the skin and mucous membrane of the ear, without rupture of the membrana tympani or fracture of the osseous canal; and thirdly, to fracture of the anterior wall of the bony canal. The second variety is not well established, and the cases and authority cited fail to convince us that perfect observations have been made. Great interest, however, centres in the descriptions of the third class of injuries to the ear. In cases of fracture of the anterior wall of the auditory canal, it is shown that the hemorrhage occurs immediately after the injury, and at the outset may be quite copious, but it invariably and rapidly stops. It is its short duration which serves to distinguish it from bleeding arising from fracture of the petrous bone, though it must not be forgotten that sometimes the latter is also short in duration.

The second chapter, in the second part, treats of traumatic lesions of the membrana tympani. These are considered under the two divisions of Duplay, viz.: those induced by direct and those by indirect causes.

According to their form and locality, ruptures of the membrana tympani may be grouped in three classes:

1. Central and stellate. To this class belong ruptures following concussion of a column of air or of water—as in a box on the ear, cannonades, diving, and the like.

2. Regular or cordiform, situated below and behind the malleus. To this class belong ruptures following strangling, hanging, retching, or rapid extravasation into the tympanum.

In the *third* class the rupture is nearly rectilinear, behind and parallel to the hammer. This form Triquet found in whooping-cough.

The first kind of rupture necessarily opens a number of capillaries, and hence, is generally followed by a copious hemorrhage, but of short duration.

In the second class of injuries the hemorrhage may also be copious.

In the *third* class the hemorrhage is very slight, when it depends simply on fissure in the drum-head; but, when dependent on extravasation into the tympanum with a secondary rupture of the drum-head, then there may be a very abundant flow of blood from the ear.

It appears, from the thesis, that the quantity of hemorrhage arising in direct perforations of the membrana tympani depends on the position of the wound, and, of course, on the number of arterioles implicated. It must also be borne in mind that a previous condition of inflammation in the drum-head has much to do with the quantity of bleeding in an injury of the membrane.

Fissure of the drum-head from indirect cause.—Under this head appear those cases of rupture of the drum-head, from falls, in which the auditory canal is apt to be fractured. Nevertheless, concussion alone in these cases is sufficient to rupture the membrane. In this section the writer of the thesis shows that not only hemorrhage, but also serous discharges, may succeed the injury, and yet entire recovery ensue. Thus, we may see, after an injury from a fall upon the head, loss of consciousness for a longer or shorter time, followed by dulness of intellect for several days, loss of hearing on one side, and hemorrhage from the ear. From all these symptoms, especially from the flow of serum—which sometimes is joined with them—a fracture of the petrous bone may be suspected, whereas they may all alike follow a rupture of the drum-head, the serous discharge being due to an inflammation in the tympanic mucous membrane. Nine such cases, collected by Le Bail, are given by the candidate, in illustration.

The interest of the reader is sustained in the third chapter, which treats of fractures of the petrous bone and the resultant symptom of hemorrhage from the external ear. It is stated that, when the fracture is perpendicular to the axis of the bone, the membrana tympani may not be ruptured, and that, hence, blood collected behind it would not be found escaping from the meatus externus. In some rare instances, even oblique fractures of the petrous bone are unaccompanied by hemorrhage from the ear; but these are very exceptional occurrences, Le Diberder alone being quoted by the candidate. Nevertheless, it may be set up as a general rule that fractures of the petrous bone give rise to hemorrhage from the ear, though the bleeding must not be considered as pathognomonic of this grave lesion. Nothing is more variable than the quantity of blood in cases of otorrhagia. In some instances only a few drops constitute the hemorrhage, while in others several hundred grammes, or even, as in a case reported by Prof. Laugier, a kilogramme of blood may escape from the ear. There are numerous reasons by which to explain the greater or less quantity of blood in these cases. Thus, the fracture may be extensive or not, the rupture in the membrana tympani or in the mucous membrane of the tympanum may be more or less complete, or the hemorrhage may originate elsewhere than in the small vessels of the mucous membrane of the middle ear, or in those belonging purely to the bone. The blood may flow from some of the large vascular trunks crossing the surface of the pyramid, when, as may be easily conceived, the hemorrhage will be very copious and death almost immediate.

It may also be said that the hemorrhage is variable in its duration. In some instances it stops shortly after its appearance, not to reappear; whereas, in other cases, it returns after a cough, a muscular effort, a movement, or from no appreciable cause. Such a variability or intermittence may be considered as exclusively characteristic of hemorrhage, dependent upon fracture of the petrous bone.

The following conclusions are then given by the writer of the thesis:

1. Traumatic otorrhagia very rarely constitutes in itself a danger. It acquires a gravity only in certain fractures of the petrous bone, when a large vessel is implicated.

2. In ruptures of the drum-head the quantity of the discharge of blood is proportionate to the seat of the fissure, rather than to its extent.

3. Otorrhagia, following a fall or a blow on the head, may depend upon a lesion of the auditory canal, a fissure of the membrana tympani or of the mucous lining of the drum, or upon a fracture of the petrous bone, and in some cases even on a fracture of the squamous portion of the bone.

4. Hemorrhages accompanying lesions of the auditory canal may be very copious at the outset, but they soon diminish, and their duration is short.

5. Ruptures of the membrana tympani, caused by indirect violence, are followed usually by only a slight bleeding.

6. The diagnostic value of otorrhagia in fractures of the petrous bone consists in its abundance, its intermittence, and especially in its persistence.

REVIEWS.

SOME APPLICATIONS OF PHYSICS TO MEDICINE. WILLIAM H. STONE: *London Lancet*, August 9, 1879.—Mr. Stone devotes one of the Croonian lectures, delivered at the Royal College of Physicians of London, to the subject of the *continuity of tactile sensation with hearing; bronchophony, ægophony, and pectoriloquy.* The lecturer begins by drawing attention to the fact that "the vibration which immediately occurs in fluids, when an obstacle is placed in a flowing stream, has many applications to the circulatory system, and, if it have only a moderate degree of rapidity, can be easily detected by the hand. The link between tactile and aural sensation is to the mind of the lecturer continuous; at the time, or before, the hand ceases to appreciate the vibration, it is recognized by the ear. When the arm is placed over the back of a chair so as to partially obstruct the axillary artery, without quite closing it, vibrations are experienced down to the arches of the hand, constituting a *physiological* instance of sensible, but not audible vibration. Similar vibrations can be produced in the veins, and it is done almost too easily by undue pressure of the stethoscope over the veins of the neck, in which case it has been termed *bruit de diable.* The lecturer thinks that a physical fact of some importance will have been established when it shall be demonstrated that vibrations can be appreciated by the sense of touch before they become rapid enough to be audible.

The lecturer illustrated tactile vibration by means of a long india-rubber tube, which was connected with a cistern. The tube being unobstructed, nothing is heard or felt in it of much importance; but the moment a vena contracta is established, the vibration becomes intense. By simply blowing through the tube, bronchial breathing takes place, and when it is pressed by the stethoscope the *bruit de diable* is heard. It would lead us too far to follow the lecturer further in the subject of auscultation, which he desires to re-examine in the light of modern researches, especially those of Helmholtz, on acoustics. In the endeavor to analyze the elements of the voice, the lecturer obtains two very distinct phenomena, namely, vocal fremitus and vocal resonance.

"The former of these is vibration of a coarse and violent kind, transmitted from the vibrating larynx through the tissues, like the presystolic thrill described above" (as occurring in hypertrophy of the heart), "and sensible to the hand placed over the pectoral region. The fact of its transmission through solid tissue, and not by the air-passages, is shown by its being distinctly felt over the head of the person speaking, and by the curious observation which I have since noticed, and have now to record, that it is very distinct all over the head during the utterance of a 'falsetto' note in what has always been appropriately called 'the head voice,' a note which entirely fails to produce any vocal fremitus over the thorax. Vocal resonance, on the other hand, is admitted to depend mainly, if not wholly, on the column of air in the trachea and bronchial tubes vibrating after the fashion of an organ-pipe. The mechanism of its transmission through healthy or solid lung has been the subject of much discussion, especially by Skoda. . . . ."

Mr. Stone filtered off the coarser fremitus from the finer musical sounds by placing a pitch-pipe between the lips, which uttered its note by drawing a deep inspiration. However loud the note which thus entered in a vibratory state, and however distinctly transmitted to the ear, it failed to produce any thoracic fremitus.

Mr. Stone here suggests that uniformity in auscultation may be obtained by using the pitch-pipe in every case, the same note being produced by all persons by whom it is employed. This musical sound was found to be but seldom conveyed, even through lung solid from pneumonia. This fact disposed of the fallacy that solid lung was a better conductor of sound than healthy tissue. From a pure note as obtained through a pitch-pipe, the vocal fremitus being absent, bronchophony only exists in the neighborhood of the large bronchi, although in phthisical cases transmission may in some instances be greater.

Mr. Stone, finding that the pitch-pipe produced no evidence of ægophony, even where it was marked with the speaking voice, resolved to observe the effect when the patient sang. He thus discovered that the result was the same as when the pitch-pipe was used. He then required the patient to whisper loudly; the ægophony was immediate and distinct as when he spoke in his ordinary conversational tone. Ægophony was therefore discovered to be absent from the musical tone, and to belong to the vocalization of the mouth and fauces, without any laryngeal ground-note. Having obtained this clew to the mechanism of ægophony, the lecturer reproduced the sound artificially. A piece of india-rubber tubing, over a yard in length and nearly an inch in bore, was obtained; over this was placed a bladder or a small india-rubber bag of water. Various tones were transmitted to the tube by means of a mouth-piece. The ear or stethoscope applied to the water-bag could scarcely detect a pure musical note, whether of pitch-pipe or voice. When, however, spoken words containing vocalized sounds were used, the ægophonic twang was loud and distinct.

Mr. Stone, in considering the curious and new observation, that a pure musical vibration within the limits of the ordinary speaking voice is not transmitted at all, either through consolidated lung or through a layer of pleuritic fluid, but that the same note, when vocalized and modified by the addition of vowel sounds, immediately passes through the obstructing media at a changed pitch, cannot avoid connecting the phenomena with Helmholtz's discoveries as to the mechanism of vocalization. Helmholtz found all vowel sounds surrounded with numerous remote harmonics. Many of the vowels were reproduced by him from a series of tuning-forks kept in steady vibration by electrical agency, especial difficulty, however, obtaining in the E and I sounds, until he reinforced the extreme high harmonics at the expense of the fundamental notes. Mr. Stone has discovered that these are exactly the sounds on which ægophony is most distinct, whether in a living lung or in an artificial india-rubber substitute. He is, therefore, led to believe "that ægophony has the same, or rather the converse, *modus operandi;* that the layer of fluid, while it stops the larger and coarser vibrations of the ground tone, lets pass the finer and closer undulations of the high harmonics." This imperfect abstract scarcely does justice to the lecture, which is of great benefit to science. We have long thought that the well-known laws of acoustics should be made more subservient to physical diagnosis, and we therefore recognize the pioneering work of Mr. Stone as the beginning of a rearrangement of the whole subject.

THE PERCENTAGE REGISTRATION OF THE SENSITIVENESS OF THE CONDUCTIVE APPARATUS OF THE EAR TO RESONANT IMPULSES OF MINIMUM INTENSITY. (Read and discussed in the Medico-Chirurgical Society, 24th of January, 1879.) A. D. STEWART: *The Glasgow Medical Journal*, May, 1879.—This paper is intended to present a method for uniform registration of the patient's hearing, a watch sound having a normal distance of about twenty feet being recommended. The watches used should have a "stop." Dr. Stewart's rather complicated procedure, which, indeed, we have not time to describe here, would not be well suited to a busy practice. In the discussion which followed the reading of the paper before the Society, a number of gentlemen present took part, and from the report an unusually intelligent interest was manifested. It was the opinion of Dr. Cassells, that to determine the degree of the acuteness of hearing by the watch was not important, as this test formed no criterion of the capability of hearing the human voice. The plan followed by Dr. Stewart was essentially that of Dr. Prout, of Brooklyn.

Dr. McVail took exception to the averment that the tick of a watch was not a proper test of the acuteness of hearing, and that the capacity to hear the human voice was really the proper test. The tones of the human voice were very complex; no two people spoke with the same tone. Even a deaf person would make out what another said, if, especially, the tones were familiar to him, while all the time he would not hear a word uttered by another person who spoke much louder. This was partly owing to the musical tone of the one voice as compared with the other. The ticks of a watch were as nearly as possible primary sounds, and, as a physiologically accurate method, nothing could be better than taking as a test, short, explosive, rudimentary sounds.

THE ANATOMY OF THE MASTOID PROCESS. ZUCKERKANDL: *Monatschrift für Ohrenheilkunde*, Vol. XIII., No. 4.—From the dissection of a case in which he found the mastoid process filled with fat tissue resembling the diploë of fresh bones, Zuckerkandl was led to investigate a large number of mastoids. One hundred of these were examined in the fresh state with the following result: The mastoid was completely pneumatic in only 40 cases, in 22 it contained red or yellow fatty tissue as far as the antrum; in 9 the lower half of the process was diploëtic or fatty, while the upper half was pneumatic; in the remaining 29 the apophysis alone, for the extent of 3–5 mm., was diploëtic, the rest of the process pneumatic.

One hundred and fifty macerated bones were then examined: In 52 of these the whole mastoid was filled with pneumatic cavities; in 20 the lower half was diploëtic, the upper half pneumatic; in 38 the extreme point of the process was diploëtic; in 7 the diploëtic substance was confined to the pars petrosa of the mastoid; in 4 the extreme point of the process for a distance of 3–5 mm. was solid bone; in the other 29 the entire process, even to the antrum, was diploëtic and more or less solid.

The observations of Zuckerkandl show that in 20 per cent. of the cases apneumatic mastoids existed, while mastoids perfectly pneumatic throughout existed in only 38.6 per cent.

CONTRIBUTIONS TO THE PATHOLOGY AND PATHOLOGICAL ANATOMY OF THE ORGAN OF HEARING. S. MOOS: *Archives of Otology*, July, 1879.—Prof. Moos continues this subject from the seventh volume of the *Archives of Ophthalmology and Otology*. The present paper describes the following cases:

B. *Three cases of secondary affection of the temporal bone in consequence of neoplasma in the posterior nares, with remarks on symptomatology and treatment.*
C. *Organic alteration in the organ of hearing in a case of auditory hallucination with psychic derangement.*
D. *Traumatic dislocation of the malleus and incus, with membrana tympani intact.*
E. *Condition after a natural healing of a purulent inflammation of both tympanic cavities.*
F. *Anchylosis of the stapes on both sides, with one-sided closure of the round window.*
G. *Results of an examination of a deaf-mute.*
H. *Foreign body in the ear. Death from repeated violent efforts at extraction.*

B. Three interesting cases. They are given with considerable detail, both as to symptoms during life and their post-mortem appearances. The last reported of these three cases was the subject of a tumor filling the whole pharyngeal vault, as well as the nasal cavity; the nose and upper maxilla were involved and much swollen, and the eyeball was pushed forward. The intercranial portion of the tumor involved the right temporal bone, the body of the sphenoid, etc. From this case the author deduces some facts regarding the symptomatology and treatment of such cases. Apart from the examination during life with the rhinoscope and finger, and the difficulties in respiration and deglutition, which are likely to be present in such cases, the following conclusions are entitled to consideration:

"1. The constant impermeability of the Eustachian tube, by all methods, a certain proof that the new formation has already affected the tube, or that the tube has already been absorbed in the tumor-mass.

"2. In consequence of the impermeability of the tube, an excessive sinking of the membrana tympani.

"3. A more or less considerable purulent inflammation of the mucous membrane of the tympanic cavity, as a symptom of the invasion of the region of the middle ear by the new-formation.

"4. Aside from the other symptoms of purulent otitis media, and aside from the pain consequent upon this, a persistent headache in consequence of pressure exerted by the enlarging new-growth.

"5. Continuous severe subjective noises, due either to the increase of intra-auricular pressure or hyperæmia of the labyrinth, as symptoms of the involvement of this region in the tumor, or to both. [A complete cessation of the subjective noises in spite of the progress of the tumor was possible in this case, owing to the fact that the whole labyrinth was involved in the tumor-mass. The large pearl-tumors in the temporal bones seem to favor this opinion.]

"6. Abolition of bone conduction for all kinds of tones.

"7. The high degree of deafness, or complete abolition of hearing power.

"8. The swelling of the cervical glands as a special indication of the malignancy of the new-growth."

C. This case is one of not uncommon occurrence in the practice of large dispensaries.

The aged, when of feeble intellect, are incapable of comprehending the phenomena of *tinnitus aurium* and *autophony*, especially when their deafness is considerable. The case reported by Prof. Moos was probably of this character; she was seventy-five years old, in feeble health, very deaf, and had had much domestic trouble. She fancied the ghost of her husband was trying to torment her with threats and strange noises, hooting, rattling of chains, and the like. These symptoms are often experienced by those in a vigorous intellectual state, without alarm being excited.

An examination of the ear after death revealed nothing beyond what is usually found in the long-standing cases of chronic mucous catarrhal inflammation of the middle ear of old people.

D. This case has its peculiar interest in the fact that, after death from a fracture of the skull, it was found that the concussion had separated the maleo-incudal joint without rupturing the membrana tympani. The anatomical diagnosis was: *Hemorrhage between the dura and skull; fissure in the right frontal bone; diastasis of the coronal and squamous sutures; rupture of the arteria meningea media. Hemorrhage into the pons cerebri.* Examination of right petrous bone showed the external meatus to be normal. "Membrana tympani intact, the periphery and the division above the short process slightly hyperæmic, otherwise normal. The bony covering of the antrum mastoideum, and the cells of the mastoid process itself, suffer from a bluish black suggilation; in the cells themselves there was dark coagulated blood. In the tympanic cavity slight hyperæmia, especially at the periphery of the membrana tympani and the head of the hammer, the connection between the upper tympanic wall and the head of the hammer severed (rupture of the ligamentum mallei superius). If this is moved with a probe, the whole hammer hangs loose in the membrana tympani, but it is not entirely detached from it, the connection is only less close than normal. The stapes lies obliquely in the tympanic cavity, with its body against the neck of the hammer, with its tympanic process against the posterior wall of the tympanum, and its detached stapedial process against the niche of the oval window." There was nothing abnormal discovered in the condition of the labyrinth.

E. Prof. Moos examined the left temporal bone of a patient who had died of pulmonary disease. During life his hearing had not been tested, as no deafness was suspected. The external meatus was unobstructed, the membrana tympani greatly thickened and retracted, the malleus being entirely concealed in its substance. The mucous membrane lining the tympanum was somewhat thickened; the articulations of the ossicles were free. The dura mater was adherent to the roof of the middle ear, and the osseous portion of the tegmen-tympani was perforated. The right tympanic cavity was also supposed to have formerly been the seat of a purulent inflammation, and presented the appearance of having suffered thereby even more than the left. That such extensive disease could have existed without great impairment of hearing is most remarkable, and the patient recovered without treatment.

F. Chronic purulent inflammation of twenty years' standing, with great deafness. The conductive apparatus was almost entirely absent on either side when examined after death. Notwithstanding the duration of the disease of the middle ear, there was no appearance of secondary alteration in the labyrinth.

G. A deaf-mute, aged twenty-nine years, died of pulmonary disease. The results of the examination, after death, show that probably there existed in early life periostitis of the petrous bones. There was found sclerosis of these bones, anchylosis of the ossicles, hyperostotic state of the bony walls of the tympanum, and osseous closure of the round window. The author found the tensor tympani muscle to be of normal structure, the same as described by him in a case previously where a patient, aged fifty-four, had never heard, and yet there was no fatty degeneration of the muscle from disuse. It is the opinion of the author that this is owing to the anatomical connection between the musc. tens. veli palatini, and tens. tymp., whereby the continual action of the tens. tymp. in the act of swallowing has prevented its fatty degeneration.

H. Cases of death from attempts to remove a foreign body from the meatus are rare. In this instance the anatomical diagnosis was *metastatic septicæmia from wounding of the ear; metastatic foci in both lungs, as well as in the muscular tissue of the right lower extremity.*

The violent effort on the part of two physicians, at different times, to remove a foreign body *without previous examination*, was the cause of the fatal termination. The author truly says: "If the foreign body had remained in the ear the patient would be living to-day." Death took place three weeks after the accident, which was supposed to have been the cause of the lodgement of the foreign body. The consequences of the forcible interference were the destruction of the chorda, denudation of the walls of the meatus and tympanum, lacerations of the membrana tympani and ossicles. These contributions to scientific otology are most valuable, and it is to be regretted that outside of Germany more work of this kind is not done.

CONTRIBUTION TO THE PATHOLOGICAL HISTOLOGY OF THE CARTILAGINOUS FRAMEWORK OF THE EAR. DR. JOSEF POLLAK: *Monatschrift für Ohrenheilkunde*, Berlin, July, 1879.—The specimens used by Dr. Pollak in his examinations were taken from the ears of individuals who had died in the Allgemeine Krankenhaus at Vienna, and who had not, so far as he could learn, been affected with any form of mental disease. At the time these examinations were made Dr. Pollak had no knowledge whatever of the researches made by L. Meyer, Parreidt, Gudden, Simon, and Fürstner, with regard to the pathology of othæmatoma. In the cartilaginous portion of the external meatus, and especially in the anthelix, small nodules were occasionally found which varied in size from a mustard seed to a lentil. In these, when cut open, it was easy to detect, even with the naked eye, a departure from the normal condition of the reticular cartilage: in some cases a distinct cavity had already begun to form. Microscopic examination of thin sections, stained with carmine and mounted in Damar varnish, brought out still more distinctly the difference between the healthy and the diseased portions of the cartilage, the latter having become deeply stained by the carmine, and standing out in marked contrast with the more feebly stained healthy portions. At these points the reticular cartilage appeared to have lost its fibrillated network, and displayed in its stead a homogeneous structureless mass, in which here and there an occasional cartilage cell could be distinguished.

In other sections, which had been simply mounted in glycerine without previous staining, quite a different picture was presented. At the periphery of the diseased spot the cartilage cells were more sharply defined than in the normal condition, and the intercellular substance appeared to have undergone rarefaction. In the central portions the fibrillæ ran in parallel bundles, had less sharp outlines than in the normal condition, and in some spots passed gradually into what appeared to be simply a mass of dark granules. In some places the withering away and destruction of the old cartilage cells could easily be recognized; in others, groups or rows of young cartilage cells could be distinguished.

In a third series of sections the formation of an actual cavity could readily be made out; and in these, furthermore, the important observation was made that the cavity lay wholly within the mass of cartilage, and at no point was bounded by the perichondrium, which everywhere appeared to be perfectly healthy.

Dr. Pollak remarks that the results of his examinations do not in any manner conflict with the view expressed by L. Meyer, viz.: that this whole process should be looked upon as a softening of the cartilage. He offers no opinion, however, with regard to the probable cause of the process, and leaves it to further investigations to determine what relation, if any, these changes bear to the development of othæmatomata.

PRIMARY EPITHELIAL CANCER OF THE EXTERNAL MEATUS. DELSTANCHE (fils): *Archiv für Ohrenheilkunde*, Vol. XV.—A fisherwoman noticed a small, hard, dry prominence on the inner surface of the tragus; this was mistaken for a furuncle, local applications were applied, and it ruptured. From this time discharge and ulceration set in, followed by intense pain in the ear, which had been going on for a year when she applied at the Hôpital St. Jean. Examination showed the walls of the meatus covered with small, fleshy, wart-like growths, which concealed the deeper parts, the passage itself being larger than normal; perforation of the membrana tympani was, however, proven on inflation; a small fistula opened between the mastoid and auricle, but the mastoid itself was not tender or swollen; no infiltrated glands. The only symptoms complained of were intense pain in the ear and objective noises. Epithelial disease was confirmed by the microscope, and the only treatment adopted was palliative. The patient was under observation till her death, eight months later. The disease gradually progressed, the meatus became a large crater-like opening, the articulation of the jaw was exposed, and the lymph-glands in the neighborhood became infiltrated, facial paralysis occurred, the drum-membrane was destroyed, the auricle became separated, and was attached merely by the lobule, which remained free from the disease; exophthalmos and total blindness of the right eye set in. Death occurred apparently from exhaustion, without delirium or insensibility.

The autopsy, which is given very fully, showed that the disease had destroyed the greater and lesser wings of the sphenoid, the posterior part of the frontal, and part of the squamous portion of the temporal bone; the petrous bone was softened; the facial nerve was in a state of caseous degeneration. In the fundus of the eye was a mass of cancroid. Membrana tympani, malleus and incus were absent, stapes in normal position; mastoid process uninjured, but in a state of complete sclerosis, the pneumatic cavities being lacking. The inner ear was not examined. Other organs all healthy.

Delstanche considers, with perfect right, that the malignant growth originated on the inner surface of the tragus. The fact that the mastoid was not involved he refers to the condition of that bone, in which all pneumatic cavities and consequently any soft structures were wanting. No sequestra were found during the whole course of the disease, the bone evidently undergoing a gradual disintegration.

THE MUCOUS MEMBRANE OF THE NASAL FOSSÆ. CHARLES RÉMY: *Thèse d'Agrégations*, Paris, 1878. Review by F. Henneguy, in the *Revue des sciences médicales*, Jan. 15, 1879.—This paper contains some original views of M. Cadiat, communicated by him to M. Rémy. It is held that the mucous membrane of the nasal fossæ is developed from the external layer of the blastodermic vesicle, in the form of a depression first, then as a cleft, and finally as a tube which is connected with a prolongation of the anterior cerebral vesicle. The tube extends to a cavity limited by the incisive bone. This cavity is divided into two at the development of the first branchial arches. M. Rémy has traced in the embryo the development of the olfactory bulb, of the nerves arising from it, and their final union with the mucous membrane. He has further determined that in the pituitary membrane of man there is but one kind of gland, and that there are no glands of Bowman.

OPERATIVE PROCEDURES IN THE TREATMENT OF POLYPI OF THE EAR. PROF. DR. ADAM POLITZER: *Wiener Medicinische Wochenschrift*, No. 16 et seq., 1879.—Prof. Politzer first calls attention briefly to the great importance of ascertaining accurately from what particular part of the ear the polypus originates. He proceeds to describe the means best adapted for the acquisition of this knowledge, and attaches to the information obtained by the use of the silver probe a value second only to that which very properly belongs to the results of ocular inspection.

With regard to the question of the removal of aural polypi, Politzer maintains that it is always a proper proceeding to remove these growths by operative [in contradistinction to chemical] interference. "Although they may often continue to grow for years without producing any injurious effects upon the patient's health, it is a well-known fact that these growths not unfrequently interfere with the escape of the secretions to such an extent as to produce a stagnation of the pus and exfoliated epithelium, both within the tympanum and in the external auditory canal. In this way cheesy masses (consisting of detritus, scales of epidermis, and crystals of cholesterin) are formed, and these, by undergoing decomposition, produce caries of the bony structures, and eventually lead to a fatal meningitis, a phlebitis of the lateral sinus, or some other equally serious complication."

The different operative procedures are classed by Politzer under two heads, the method by *extraction* and that by *excision* (with the wire loop). The old practice of simply seizing the mass with the dressing-forceps, and, without any previous exploration of the tumor's connections, pulling it out by a sudden jerk, is condemned by the author as in the main an objectionable method. At the same time he is unwilling to assent to the doctrine, now very generally taught, that polypi of the ear should never be removed by extraction. In certain cases, as Politzer maintains, the method by extraction is to be preferred to all other methods of removing these growths. Where, for instance, the polypus grows from some part of the external auditory canal, and the exact point of origin has been accurately determined, extraction is to be preferred to excision. By this method time is economized and the growth is usually much more thoroughly removed. A subsequent return of the polypus is also less likely to occur after extraction than after excision.

With regard to the steps of the operation (extraction), Politzer recommends the use of Wilde's snare, the wire loop of which is to be passed down over the growth as near as possible to the peduncle, and then drawn around the mass with sufficient tightness to hold it firmly. Steady but firm traction usually then suffices to remove the polypus entire. If the employment of a moderate degree of force fails to bring away the mass, the wire (still firmly encircling the growth) should be twisted upon itself and then cut off near the instrument. The distal portion of the polypus, being shut off from its supply of blood, soon mortifies and separates. In a few cases Politzer has observed a withering and separation of the entire growth, after such a process of strangulation.

In cases where the polypus is large, and its point of origin cannot be accurately ascertained by means of the probe, excision by means of the wire loop should be preferred to extraction. As regards the choice of instrument suitable for this purpose, Prof. Politzer says that Blake's and Hartmann's snares are preferable to the original Wilde's instrument; in cases of polypi that spring from the mucous membrane of the middle ear, he gives decided preference to the American instrument. For the destruction of the stump which remains after incomplete extraction or excision with the wire loop, Politzer is in the habit of using a ring-shaped knife, by means of which he is easily able to scrape or cut away whatever may remain of the original growth.

In conclusion, Politzer makes a few remarks on the employment of caustics for the destruction of granulation growths and stumps of polypi in the ear.

For years he has been in the habit of using nitrate of silver in the form of a small bead fused upon the end of a probe or wire. Of late, however, he has rather given the preference to the liquor ferri sesquichlor. The latter reagent is to be preferred, he says, because it is less apt to cause pain, and also because it penetrates to a much greater depth in its destructive action.

MYRINGOPLASTY. BERTHOLD: *Monatschrift für Ohrenheilkunde*, Nov., 1878.—Prof. Berthold reports two cases in which he made the attempt to replace a portion of the membrana tympani which had been destroyed by ulceration, by transplanting a piece of the natural skin taken from the arm. In both of these cases the attempt was crowned with entire success.

In the first case the patient, an apothecary's clerk, aged twenty-two years, had been subject to otorrhœa (double) since childhood. His hearing varied at different times, but of late had become so poor that he was obliged to give up his clerkship. An examination with the speculum and reflected light revealed the existence of a perforation in each drum-membrane, with a markedly swollen condition of the mucous membrane of the middle ear. On the right side the perforation was situated low down anteriorly, and, owing to the curvature of the canal, could not be seen throughout its entire extent. On the left side the perforation, whose diameter was between 3 and 4 mm., was more centrally situated, and did not extend quite to the lower periphery of the membrane. The hearing, too, was better than on the right side. A preliminary course of treatment, consisting of astringent applications to the swollen mucous membrane and inflations with the air-douche, was carried on for a period of a few weeks. The hearing was thereby materially improved, and the otorrhœa on the left side was entirely arrested. This ear, therefore, was thought to be in a favorable condition for the operation contemplated. As a first step a piece of "English plaster," somewhat larger than the perforation, was applied to the drum-membrane in such a manner as to cover up not only the perforation, but also the surrounding edges of the membrane over quite a broad zone. The object of this step was to remove the epithelium from these parts, and so render them susceptible of forming adhesions with the part to be transplanted. Three days later the piece of plaster was removed by syringing, the middle ear and outer surface of the membrana tympani were carefully dried, and then the small but rather thick piece of skin, taken with the scissors from the forearm, and composed in its central portion of all the layers of the skin, was cautiously applied—with its raw surface turned inward—to the desired locality on the drum-membrane. The outer orifice of the external auditory canal was plugged with a piece of cotton-wool which had been dipped in a solution of salicylic acid in glycerine (1:60).

On the following day the ear was examined and the transplanted piece of skin was found to present a decidedly cadaverous appearance, its lower portion having a brownish hue. The patient, however, volunteered the statement that his hearing was already better since the transplantation had been performed.

On the third day the small piece of skin was found to have undergone still further shrinkage, but otherwise no change could be detected. There was no appreciable injection of the blood-vessels of the membrana tympani.

On the fourteenth day a three per cent. solution of carbolic acid was dropped into the external auditory canal—for what purpose, is not stated. This caused the outer surface of the piece of skin to swell up like a sponge, and a very feeble pulsation could be distinguished between it and the posterior limit of the drum-head. After the solution had been entirely removed from the canal, and the parts had been allowed sufficient time to dry, a minute perforation was discovered at the posterior edge of the larger old perforation. At this point, consequently, no adhesions had formed between the transplanted piece of skin and the membrana tympani.

On the fifteenth day the air-douche was used. No appreciable change could be detected in the relation of the parts after this procedure; the exposed portions of the membrana tympani were simply a little reddened by it.

On the eighteenth day the external auditory canal was syringed with lukewarm water, which brought away the upper portion of the transplanted piece of skin. The ear was then examined and the opening in the drum-membrane found to be closed (except at the small spot referred to above) by a new membrane rather whiter than the adjacent drum-head tissue, and somewhat raised above the surrounding level. On the twentieth day the closure was found to be complete.

On the twenty-first day the ear was again syringed and another fragment of membrane escaped with the water. On careful examination it was found that the minute perforation still existed.

On the twenty-fourth day a small piece of silk protective was laid upon the membrane over the perforation.

In the early part of September (the operation was performed on the firs day of August), the perforation was found to be entirely healed over. Th newly filled-in portion of the membrane presented a more yellowish and whitish appearance than the surrounding parts. The hearing, for whispered words, had improved from less than one metre to fully five metres.

The second case reported by Prof. Berthold was also a successful one. It presented, however, no features either of special interest or differing materially from those observed in the first case.

THE TREATMENT OF EXOSTOSES OF THE MEATUS. BREMER: *Hospitals Tidende*, No. 2, 1879.—In an ear completely closed by exostoses of the meatus, Bremer succeeded in two sittings in removing the growths with a chisel. Bleeding and extensive suppuration followed the operation, and granulations were found which required removal with the sharp spoon and caustics. After fourteen days laminaria bougies were used with local applications, and the result was an irregular meatus, 3–4 mm. in diameter, and great improvement to the hearing. Nine months later the result was unchanged, the meatus was of a fair size and lined with healthy skin, all discharge had ceased, and the healing was good.

ANTISEPTIC TREATMENT OF SUPPURATION OF THE MIDDLE EAR. BEZOLD: *Archiv für Ohrenheilkunde*, Vol. XV., Part 1.—The two chief conditions for an effective antiseptic dressing, perfect disinfection of the whole wounded surface and complete closure from the air, seem at first sight to forbid the application of these principles to the tympanum, for it is impossible to hermetically close the Eustachian tube and also impossible to thoroughly disinfect all the irregularities of the tympanum and mastoid. Surgery, however, Bezold says, has these same conditions to deal with in the neighborhood of the mouth and nose, around the genitals and the anus, and yet experience shows that in these parts an incomplete antiseptic dressing is of value.

Disinfection by syringing with permanganate of potash and carbolic acid has been used for a long time, and von Troeltsch has recommended, in order to check the deposit of new septic spores after the inflamed surface has been thoroughly cleansed, to close the meatus with charpie saturated with carbolic or salicylic acid.

In selecting an antiseptic for the ear it is necessary that it should not be irritating to the mucous membrane of the tympanum, and also that it should not form deposits either by itself or from chemical union with the natural secretions, as such deposits often act as mechanical irritants.

Carbolic acid, although useful in ½–1 per cent. solution for cleansing in caries or necrosis, is not well borne, Bezold says, by the tympanic mucous membrane in uncomplicated purulent otitis media, for the mucosa then becomes from its use more swollen, and the secretion is increased.

In chronic suppuration of the tympanum Bezold found the use of salicylic acid, especially in alcoholic solution, useful; but the same is not well borne in acute cases. Thymol acid, he says, is also well borne, but his experience of it was slight, and he does not speak of results.

All of these antiseptics, however, Bezold has given up since learning the virtues of boracic acid, which he considers equal to any of the other substances as an antiseptic, and it has the advantage over them of producing no reaction of the tympanic mucous membrane. After first trying a saturated solution of the acid, and getting no better effect than from similar solutions of the other antiseptics, he tried filling the meatus with finely pulverized boracic acid, and, as the result, asserts that this method of treatment is so much more certain, and so much quicker than other methods, that he now uses it in every case of suppuration either of the meatus or tympanum, and also after lesser operations, such as removal of polypoid granulations, cauterization, and paracentesis; he excepts, however, extensive disease of the bone and perforation of the mastoid. He does not consider that it supplants, but rather assists other methods of treatment, like the antiseptic dressing in surgery; cauterization of granulations, removal of polypi, etc., are still as necessary as ever.

The meatus and tympanum are first cleansed carefully with a four per cent. solution of the acid, then dried thoroughly and finely pulverized boracic acid blown in over the suppurating surface; the meatus is then closed with salicylic, carbolic, or boracic cotton.

Statistics are given to show the favorable action of this treatment of twenty-nine cases of otitis media purulenta acuta; the average duration of the otorrhœa was thirteen days; of one hundred and sixteen cases of otitis media purulenta chronica, the average duration of treatment to the cessation of all discharge was nineteen days.

The pulverized acid has the advantage of producing no reaction on the mucous membrane, of withdrawing the water from the membrane, which keeps a saturated solution in contact with the inflamed surface, and of not forming coagulations with the secretions. In cases of otorrhœa complicated with phthisis of the lungs, the acid had no effect on the discharge.

The latter part of Bezold's article is taken up with the histories of seven cases of perforation of Schrapnel's membrane, which have little to do with the subject of antiseptic treatment.

DRY CLEANSING IN OTORRHŒA. BECKER: *Monatschrift für Ohrenheilkunde*, Vol. XIII., No. 5.—The author recommends the thorough cleansing of the ear in otorrhœas, by wiping with pledgets of cotton till all discharge has been removed, as much preferable to the use of water by the syringe or douche. The article offers nothing new, and wholly ignores the beneficial effects of allaying inflammation, which can often be obtained by a douche of water.

AN UNUSUAL CASE OF PURULENT INFLAMMATION OF THE TYMPANUM. KATZ: *Berliner klinische Wochenschrift*, No. 16, 1879.—A child nine years old had suffered for eight days only with acute inflammation of the tympanum, the ears previously having been healthy. Examination showed the usual appearances of this disease, with perforation of the drum-membrane below the umbo. After cleansing the meatus, and drying it thoroughly, Katz found that pressure upon the internal jugular vein immediately forced pus through the perforation, and as soon as the pressure ceased the discharge through the perforation ceased. This phenomenon was noticed on three successive days. A burrowing abscess below the tympanum was very unlikely from the appearances, and also from the fact that the flow of pus was produced only by pressure upon the jugular, and not by pressure at any other spot. Katz considers, and probably correctly, that the floor of the tympanum over the jugular fossa was defective, either from caries or from congenital malformation, so that pressure upon the vein, by distending its bulb, forced the pus which lay upon the floor of the tympanum up through the perforation. Caries seems, as he says, very improbable from the short duration of the disease, and there is every probability that there existed a congenital dehiscence such as has been described by many observers. It is to be regretted that the final result of the disease is not given, as phlebitis of the vein could easily follow from its intimate relation with the seat of inflammation.

PRIMARY ACUTE INFLAMMATION OF THE MIDDLE EAR. H. KNAPP: *Archives of Otology*, May, 1879.—This is the title of a paper read before the Medical Society of the County of New York, February 24, 1879. It gives the results of the author's experience in this class of diseases, which is based on his own observations of one hundred and eighty-two cases, although in the general discussion he draws on the data of others. In the author's experience the greatest number of cases of the acute affection under consideration was found to occur among those under 11 years of age, and the next period of importance, as regards the frequency of the number affected, was from the 31st to the 40th year. There were more cases in winter than in summer.

Under the head of Etiology, the principal causes of the affection, as relates to frequency, are stated to be: 1st. Affections of the Naso-pharynx, which was a cause in 63.74 per cent. of Dr. Knapp's patients. Sea-bathing occasioned 8.19 per cent.; scarlet fever, 7.14 per cent. Diphtheria, measles, pneumonia, etc., go to make up the rest. The first named cause embraces the consequences of exposure to cold. To the influences of sea-bathing the author attributes 8.19 per cent., but makes no allusion to a paper which appeared in the *Medical Record* on the same subject more than a year ago. This independent confirmation of the statements there made tends to enhance the probability of their accuracy.

In the *treatment* of this affection Dr. Knapp places rest at the head of the list of means to be employed for its cure. He advises patients with acute otorrhœa to remain in bed. In this he expresses what the experience of many aurists will confirm, although those whose observations have been most extensive would make the requirement of remaining in bed somewhat conditional, inasmuch as it is well known that patients with acute affections of the middle ear frequently have a painful irritation of the facial nerves, which is the most serious symptom to be combated, and which prevents the patient from obtaining much rest in bed while it remains unrelieved.

The author of the paper believes in the local application of leeches, and the use of warm and moist applications to the ear, especially by means of steaming. He always treats the naso-pharyngeal cavity with astringent solutions of nitrate of silver, alum, tannin, etc., of the strength of from one to three per cent.

The author states that when swelling of the mucous membrane of the

Eustachian tubes is a complication of the disease, he always uses astringent injections, by means of the catheter, using care to avoid forcing the liquid into the tympanum. We are not informed how a differential diagnosis is made in these cases, nor how often they occur in his experience. Inflation of the middle ear, either by Politzer's method, or with the catheter, was practised in all cases. The author's method is to first inflate the cavity by means of the catheter, and then make a vigorous use of Politzer's method. As the author mentions that the acuteness of hearing was increased after these experiments, we are justified in inferring that one object in their use was the improvement of hearing. This practice, as well as the use of irritating instillations into the ear, through the external auditory canal, in acute cases, has the sanction of many aurists whose standing is undisputed: but there are others, who, on the contrary, believe that the injury usually done by this course of treatment is much too great for the small good which may possibly obtain in a few exceptional cases. The attempt to improve the acuteness of hearing during the progress of acute catarrhal inflammation of the middle ear, does not seem warranted under any circumstances; and that it may be the cause of pain, and increase of deafness, is stated to have been the experience of the author in some of his cases. It would be a good plan to give the ear *rest*, as well as the patient, in the treatment of these affections.

The author is not favorably impressed with the practice which leads to the frequent opening of the membrane in these cases, by an operation, and his strictures on that procedure will receive the acquiescence of a large number.

The author, however, often practised Wilde's incision over the mastoid, which he says commonly afforded relief. We may be permitted to say here that this operation with some is as fashionable as is opening the membrane by others, and the experience and observation of many aurists lead them to the belief that it is likely to be attended by far more serious results.

The author prefers lukewarm water, to which a small quantity of table salt or soda has been added, for syringing the ear. Why this is preferred to plain water is not stated. Collections of matter in the walls of the meatus and surroundings of the ear were removed by incisions. This painful procedure, it is claimed by some, can in most instances be avoided by the use of remedies which experience has shown to not only favor the absorption of pus when formed, or hasten maturation, but which, when judiciously used, prevent the appearance of these painful complications.

Dr. Knapp's paper will have served a useful purpose in stimulating further discussion of this important subject.

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NOTES.

The Editors desire to make the following announcements in regard to the forthcoming volumes of the AMERICAN JOURNAL OF OTOLOGY:

The editorial staff will be increased by the addition of Prof. Alexander Graham Bell.

The list of contributors will include, among others: Prof. Eli W. Blake, Brown University; Dr. Elliott Coues, U.S.A.; Prof. C. R. Cross, Mass. Inst. Tech.; Prof. A. E. Dolbear, College Hill; Thomas Alva Edison; Dr. David Hunt, Boston; Dr. Henry D. Noyes, New York; Dr. Urban Pritchard, London, England; Prof. John Trowbridge, Harvard University; Dr. Samuel Theobald, Baltimore; Dr. Edward Woakes, London, England.

In addition to the quarterly bibliographical index there will be issued with the first number of each succeeding volume an alphabetical index of all publications on Otological subjects during the year preceding. This index will be made as complete as possible, and readers will confer a favor by calling the attention of the Editor to any omissions noticed or errors found therein.

As, in addition to its subscription list, the exchange list of this journal is made to include not only the principal medical and scientific journals, but also many American and foreign scientific societies and academies, a wide distribution for the papers of its contributors is ensured.

At the annual meeting of the American Otological Society, held in Newport, R. I., July 23, 1879, the following papers were presented:

1. Report on the Progress of Otology.
    a. Anatomy and Physiology. J. J. B. Vermyné.
    b. Pathology and Therapeutics. D. Webster.
2. Clinical Remarks upon Fifteen Hundred Consecutive Cases of Ear Disease. C. R. Agnew.
3. Case of Ménière's Disease, Produced by Metastasis of Parotitis. Henry D. Noyes.
4. Contribution to the Pathology of the Temporal Bone. T. R. Pooley.
5. Facial Paralysis Accompanying Purulent Inflammation of the Middle Ear. Clarence J. Blake.
6. Trephining the Mastoid in a Case of Acute Suppurative Otitis Media; unusually rapid recovery. H. Knapp.
7. Exhibition of a Cochlea Discharged from the Ear of a Child two years old. John Green.
8. Exhibition of a Sarcoma of the Auditory Nerve. George T. Stevens.
9. A Case of Supernumerary Auricle of Rudimentary Development. H. Knapp.
10. On the Treatment of Certain Forms of Diffuse External Otitis. Charles J. Kipp.
11. On the Use of Permanganate of Potassa in Chronic Otorrhœa. Lucien Howe.

At the annual meeting of the British Medical Association, held in Cork, August 5, 1879, in the sub-section of Otology, the following papers were presented, in addition to the subjects previously announced for discussion:

1. On the Production of Artificial Deafness, being an Experiment in Physiological Acoustics, and its Bearing on the Etiology and Evolution of Diseases of the Ear. J. Patterson Cassells, Glasgow.
2. Throat-deafness, associated with Paresis of the Palato-tubal Muscles. E. Woakes, London.
3. Intra-tympanic Injections. Weber-Liel, Berlin.
4. The Treatment of Non-Suppurative Hypertrophic Catarrh of the Middle Ear. Lennox Browne, London.
5. On the Treatment of Relaxed Membrana Tympani. W. A. McKeown, Belfast.
6. The Audiometer as an Exact Test of Hearing. Lennox Browne, London.
7. Perforation of the Membrana Tympani. A. Bonnafont, Paris.
8. Cases of Aural Exostoses. F. M. Pierce, Manchester.
9. On the Etiology of Aural Exostoses, and on their Removal by a New Operation. J. Patterson Cassells, Glasgow.

10. A Contribution to the Knowledge of Fungous Ear Disease. B. **Löwenberg**, Paris.
11. Three Hundred and Seventeen Cases of Ear Disease, in One Hundred and Sixty-six of which Tinnitus Aurium existed as a Prominent Symptom. **Laurence Turnbull**, Philadelphia.
12. The Forms, Causes, and Treatment of Tinnitus Aurium. W. **Douglas Hemming**, Bournemouth.
13. On the Occurrence of Exostoses Within the External Auditory Meatus in Prehistoric Man. **Clarence** J. **Blake**, Boston.
14. Ear Diseases and Life Assurance. J. **Patterson Cassells**, Glasgow.
15. Note on Tinnitus Aurium. **Samuel Sexton**, New York.
16. Inflation of the Middle Ear in Cases of Cleft-palate, both before and after Staphyloraphy.
17. Chloroform Vapor in Inflation of the Middle Ear. C. S. **Turnbull**, Philadelphia.

At the annual meeting of the American Association for the Advancement of Science, held in Saratoga, August 27, 1879, the following papers on Otological subjects were presented:

1. On a New Form of Resonant Tuning-fork. T. A. **Edison**.
2. On Binaural Audition. A. **Graham Bell**.

INDEX TO VOL. I.

Acoustic apparatus in the organ of hearing of the heteropods, 227.
—— wave-surfaces, researches in the determination of their forms, 282.
Acoustics, studies in, 222.
Adenoid tumors of the naso-pharynx, 128.
Ægophony. 296.
Alum in aural therapeutics, 287.
Anatomy of the ear, normal and pathological, 78.
Antiseptic treatment of suppuration of the middle ear, 308.
Aquæductus cochleæ in man, 227.
Ascophora elegans in the ear of man, 11.
Aspergillus in the living human ear, 10, 98.
—— rubens, in the ear of man, 11.
Atresia of the foramen ovale, 77.
Atropia, value of, in the treatment of acute inflammation of the middle ear, 201.
Audibility of high musical tones, 267.
Auditory canal, syphilitic disease of, 26.
Aural surgery in general practice, 234.
Auricle, development of, 252.
—— early formation of, in the human embryo, 70.
—— extensive wound of, 155.
—— syphilitic disease of, 26.
—— tumors of, 67.
Ayrton, N. E., on the music of color and motion, 59.

Becker, on dry cleansing in otorrhœa, 309.
Bell, A. Graham, on vowel theories, 163.
Berthold, on myringoplasty, 306.
Bezold, on antiseptic treatment of suppuration of the middle ear, 308.
Biaute, M., on tumors of the auricle, 67.
Bibliographical index, 156, 235, 312.
Bichat, M., on the measurement of the velocity of sound, 59.
Binaural audition, phenomena of, 143.
—— theory of, 225.
Blake, Clarence J., on audibility of high musical tones, 267.
—— graphic and photographic illustration of sound-waves, 3, 89.
—— on the logographic value of consonant sounds in relation to their transmission by telephone, 181.
Blake, E. W., machine for drawing compound harmonic curves, 81.
Blarina brevicauda, outer ear of, 161.
Book notices, 45, 128, 209, 291.
Boracic acid, value of, in treatment of suppuration of the middle ear, 308.
Bougies, use of, in treatment of nasal affections, 264.
Bouteille, on othæmatoma of the auricle in the insane, 69.
Bremer, Victor, on the treatment of osseous tumors of the auditory canal, 228, 307.
Bright's disease, auditory affections in, 186.
Bronchophony, 296.
Buck, Albert H., on syphilitic affections of the ear, 25.
—— a case of intratympanic vascular growth, with membrana tympani intact, 126.
Bückner. contributions to the normal and pathological anatomy of the ear, 78.
Bürkner, K., intermittent perception of sound transmitted through the cranial bones, 145.
—— rarefactions and defects in the tegmen tympani, 146.
Burckhardt-Merian. contributions to the pathological anatomy of the ear, 230.
Burnett, C. H., on aspergillus in the living human ear, 10, 93.

Calcium sulphide, use of, in the treatment of otitis externa, 41.
Cancer, primary epithelial, of the external meatus, 303.
Caries of the petrous bone a cause of meningitis, 80.
Cartilaginous framework of the ear, pathological history of, 302.
Claus, on the organ of hearing of the heteropods, 227.
Cochlea of reptiles and birds, histological studies of, 227.
Color and motion, the music of, 59.
Compound harmonic curves, machine for drawing them, 81.
Condylomata of the external auditory canal, 28.
Coues, Elliott, on the outer ear of blarina brevicauda, 161.

Dalby, W. B., on disease of the mastoid bone, 148.
Dartigolles, U., extensive wound of the auricle, 155.
Delstanche (fils), a case of primary epithelial cancer of the external meatus, 303.
Dolbear, A. E., sound vibrations and the telephone, 241.
Drum-head, paracentesis of, 71.
Drum-membrane, peculiar peripheral opacity of, 139.
Dry cleansing in otorrhœa, 309.
Ducretet, stethoscopic microphone of, 57.
Duhamel, vibroscope of, 4.

Ear, injury to, from fracture of the skull, 73.
Eczema of the ear, 48.
Edison's phonograph, 5, 224.
Edmunds' electrical phonoscope, 57.
Emboli in the tissue of the ear, 151.
Emissary veins of the mastoid process, inflammation of, 187.
Epithelial cancer, primary, of the external meatus, 303.
Eustachian tube, development of, 251.
Examination in otology, in the case of candidates for the degree of doctor of medicine, 136.
Exostoses in the auditory canal, 228, 229.
—— treatment of, 307.

External ear passages, development of, 250.
External meatus, obstruction of, 78.
Eyelet, removal of, from the middle ear, 75.

Field, George P., Treatise on Diseases of the Ear, 291.
Fissure of the drum-head, 294.
Fluid columns, structure of, when affected by sounds, 58.
Fœtal condition of the middle ear, period when it disappears, 76.
Foramen ovale, atresia of, 77.
Foramen rotundum, marked stenosis of, 189.

Galton's whistle, 267.
Gautier, on hemorrhage from the ear after severe injuries, 293.
Gellé, on the period at which the fœtal condition of the middle ear disappears, 76.
—— post-mortem appearances of the organ of hearing, in a case of persistent hallucinations of hearing, 232.
Gervais, Henri, on mastoid abscesses, 215.
Graphic and photographic illustration of sound-waves, 3, 89.
Graphium penicilloides in the ear of man, 11.
Green, J. Orne, on otitis intermittens, 112.
—— on phlebitis of the venæ emissariæ mastoideæ, 187.
Gruber, peculiar peripheral opacity of the drum-membrane, 189.
Guthrie, Frederick, on molecular physics and sound, 209.

Hagenbach, E., transmission of the higher tones by the telephone, 225.
Hallucinations of hearing, case of, with post-mortem examination, 232.
Harmonic curves, simple and compound, 81.
Hartmann, A., sequestra in the mastoid process of children, 146.
—— softening of the ossicula, 189.
Hemorrhage from the ear after severe injuries, 293.
Heteropods, organ of hearing of, 227.
Hicks, J. L., a case of acute otitis media, with symptoms of meningitis; recovery, 205.
High musical tones, audibility of, 267.
Higher tones, transmission of, by the telephone, 225.
Hotz, Dr. F. C., a case of fatal meningitis following caries of the petrous bone, 80.
Hughlings-Jackson, J., auditory vertigo, 231.
Hunt, David, on the development of the external ear passages, 250.
Hydrobromic acid in the treatment of tinnitus, 63.

Incisions in the treatment of otitis externa, 42.
Inflation of middle ears, Politzer's method, 53.
Intensities (relative) of the sensations of sound, proposed methods of measuring them, 87.
Intermittent otalgia, 76.
Intermittent otitis, 112.
Intermittent perception of sound transmitted through the cranial bones, 145.
Iodoform in aural therapeutics, 287.

Jaques, W. W., effect of the motion of the air, within an auditorium, upon its acoustic qualities, 142.
—— velocity of very loud sounds, 141.
Jugular vein exposed at the bottom of the tympanum in a case of otitis media purulenta, 309.

Katz, an unusual case of purulent inflammation of the tympanum, 309.
Knapp, Chas. P., a case of mastoid disease, 148.
Knapp, H., on primary acute inflammation of the middle ear, 310.

König's phonautograph, 4.
—— rods, 267.

Labyrinth, development of, 255.
—— histological studies of, especially in reptiles and birds, 227.
—— syphilitic diseases of, 33.
Ladd, N., on Edmunds' electrical phonoscope, 57.
Loewe, on the early formation of the auricle in the human embryo, 70.
Löwenberg, B., naso-pharyngeal adenoid tumors, 128.
Logographic value of consonant sounds in relation to their transmission by telephone, 181.

Macdonald, John Denis, on the anatomy of the organ of hearing in relation to the discovery of the principle of the microphone and magnophone, 56.
Machine for drawing compound harmonic curves, 81.
Mastoid abscesses, 215, 233.
Mastoid process, anatomy of, 299.
—— disease of, 148.
—— of children, sequestra in, 146.
—— operative procedures upon, 209.
Mayer, Alfred M., proposed methods of measuring the relative intensities of the sensations of sound, 87.
—— experimental researches in the determination of the forms of acoustic wave-surfaces, leading to the invention of the topophone, an instrument to determine the direction of a source of sound, 282.
Measuring the relative intensities of the sensations of sound, methods of, 87.
Membrana tympani, development of, 253.
—— paracentesis of, 71.
—— phonautograph, 8.
Meningitis (fatal) following caries of the petrous bone, 80.
—— symptoms of, in a case of acute inflammation of the middle ear; paracentesis of the membrana tympani; recovery, 205.
Meyer, P., histological studies of the membranous labyrinth, 227.
Microphone and magnophone, principle of, 56.
—— stethoscopic, of Ducretet, 57.
Middle ear, primary acute inflammation of, 311.
—— syphilitic disease of, 30.
Moldenhauer's account of the development of the external ear passages, 250.
Molecular physics and sound, 209.
Moore, Dr., of Rochester, a case of audible speech with closed glottis, 169.
Moore, W. O., on otitis media purulenta chronica, 149.
Moos, S., Contributions to the Pathology and Pathological Anatomy of the Organ of Hearing, 299.
Motion of the air within an auditorium, effect of, upon its acoustic qualities, 142.
Mucor mucedo seu fuscus in the ear of man, 11.
Music of color and motion, 59.
Myringoplasty, 306.

Nasal fossæ, mucous membrane of, 304.
Naso-pharyngeal adenoid tumors, 128.

Obstruction of the external meatus and tympanum, 78.
Occipital artery, ligation of, for relief of persistent tinnitus aurium, 151.
Organ of Corti, development of, 60.
Osseous tumors of the auditory canal, 228.
Ossicula, development of, 255.
——, softening of, 189.
Otalgia intermittens, 76.
Othæmatoma of the auricle in the insane, 69.
Otitis intermittens, 112.
Otitis media purulenta chronica, 149.

Otoconia, function of, 56.
Otolith (single), function of, 56.

PALATO-TUBAL muscles, paresis of, in connection with throat deafness, 259.
Paracentesis of the drum-head, 71.
Paresis of the palato-tubal muscles in connection with throat deafness, 259.
Pathological Anatomy of the Ear, by Schwartze (review), 45: article by Burckhardt-Merian, 230; article by Moos, 299.
Pectoriloquy, 296.
Phlebitis of the venæ emissariæ mastoideæ, 187.
Phonautograph and vowel theories, 172.
—— of König, 4.
—— of Scott, 4.
Phonograph and vowel theories, 174.
—— first idea of, 5.
Phonoscope, electrical, of Edmunds, 57.
Photographic illustration of sound-waves, 3.
Physics, application of, to medicine, 296.
Pissot, Paul, auditory affections in Bright's disease, 136.
Pneumatic retractor of Woakes, 66.
Politzer, Dr. A., Treatise on Otology (review), 51.
—— method of inflating the middle ears, 53.
—— operative procedures in the treatment of polypi of the ear, 304.
Pollak, J., on the pathological histology of the cartilaginous framework of the ear, 302.
Polypi of the ear, operative treatment of, 304.
Preece, W. H., on the synthetic examinations of vowel sounds, 222.
Pritchard, Urban, on the development of the organ of Corti, 60.
Pulsating drum-membrane, 120, 126.
Purves, Dr. Laidlaw, on paracentesis of the drum-head, 71.

RAYLEIGH, on the determination of the rate of vibration of tuning-forks, 144.
Rémy, Charles, on the mucous membrane of the nasal fossæ, 304.
Reyburn, Robert, on persistent tinnitus aurium, followed by symptoms of cerebral embolism; successfully treated by ligation of the posterior occipital artery, 151.
Ridout, R. H., on the structure of fluid columns which are affected by sounds, 58.
Ringer, S., statement of, with regard to the sulphides, 42.
Roosa, Treatise on Diseases of the Ear (review), 51.

SCHWARTZE, H., Treatise on the Pathological Anatomy of the Ear, 45.
—— on opening the mastoid process by operation, 209.
Scott's phonautograph, 4.
Sequestra in the mastoid process of children, 146.
Sexton, Samuel, on the use of calcium sulphide in the treatment of otitis externa, 41.
Softening of the ossicula, 139.
Sound, instrument for determining the direction of, 282.
—— lectures on, by Prof. Tyndall, 140.
—— measurement of its velocity, 59.
—— vibrations and the telephone, 241.
—— waves, graphic and photographic illustration of, 3, 89.
Sounds, very loud, velocity of, 141.
Spencer, H. N., iodoform and alum in aural therapeutics, 287.
Stapes, absence of, 77.
Steinhauser, Anton, theory of binaural audition, 225.
Stein's (Dr. S. T.) method of photographing the vibrations of tuning-forks, 8.
Stenosis of the foramen rotundum, 139.
Stewart, A. D., the percentage registration of the sensitiveness of the conductive apparatus of the ear to resonant impulses of minimum intensity, 298.
Stroh, A., on the synthetic examinations of vowel sounds, 222.
Stethoscopic microphone of Ducretet, 57.
Stone, Wm. H., some applications of physics to medicine, 296.
Synthetic curve machine of Preece and Stroh, 81.
Syphilitic affections of the ear, 25.

TACTILE sensation, continuity of, with hearing, 296.
Tegmen tympani, rarefactions and defects in, 146.
Telephone and sound vibrations, 241.
Theobald, Samuel, on the value of atropia in the treatment of acute inflammation of the middle ear, 201.
Thompson, S. P., on phenomena of binaural audition, 143.
Throat deafness associated with paresis of the palato-tubal muscles, 259.
Tinnitus aurium, 61, 219.
—— relieved by ligation of the posterior occipital artery, 151.
Topophone, researches leading to its invention, 282.
Traumatic affections of the ear, 153.
Trautmann, F., on emboli in the tissues of the ear, 151.
—— on traumatic affections of the ear, 153.
Tricothecium, in the ear of man, 11.
Troeltsch, petition asking that candidates for the degree of doctor of medicine be required to pass an examination in otology, 136.
Tumor, vascular, intratympanic, 120, 126.
Tumors of the auricle, observations on, 67.
Tuning-forks, determination of the rate of vibration of, 144.
Turner, William, on exostoses within the external auditory meatus, 229.
Tyndall, lectures on sound, 140.

URBANTSCHITSCH'S account of the development of the external ear passages, 251.

VALSALVA'S experiment, 54.
Vascular tumor of middle ear, with a pulsating intact drum-membrane, 120.
Velocity of sound, measurement of, 59.
—— of very loud sounds, 141.
Vertigo, auditory, 231.
Vibroscope of Duhamel, 4.
Voltolini, on otalgia intermittens, 76.
—— on otitis intermittens, 118.
—— on the removal of an "eyelet" from the middle ear, 75.
Vowel sounds, synthetic examinations of, 222.
—— theories, 163.

WAUGHOP, J. W., a case of mastoid abscess, 233.
Wave-surfaces, acoustic, researches in the determination of their forms, 282.
Weber, Wilhelm, method of recording vibrations of sonorous bodies, 3.
Weber-Liel, on otitis intermittens, 117.
—— on the aquæductus cochleæ in man, 227.
Weir, Robert F., two cases of intratympanic vascular tumor, 120.
Whistle of Galton, 269.
Woakes, Edward, on deafness, giddiness, and noises in the head, 219.
—— on throat deafness, in connection with paresis of palato-tubal muscles, 259.
—— on tinnitus aurium, 61.
—— pneumatic retractor, 66.
Wolf, Oscar, experiments with Edison's phonograph, 224.
Wreden's myringomycosis aspergillina, 10.

ZUCKERKANDL, marked stenosis of the foramen rotundum, 139.
—— on atresia of the foramen ovale, and absence of the stapes, 77.
—— on obstruction of the external meatus and tympanum, 78.
—— The anatomy of the mastoid process, 299.

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